SCHOOL OF ENGINEERING

THE UNIVERSITY OF SANTA CLARA

BULLETIN

1969-1970

SERIES IV NUMBER III

SANTA CLARA · CALIFORNIA · 95053

SCHOOL OF ENGINEERING

SERIES IV 1969 NUMBER III

UNIVERSITY OF SANTA CLARA BULLETINS

Colleges of Humanities and Sciences . . . No. I
Schools of Business . . . . . No. II
School of Engineering . . . . . No. III
School of Law . . . . . No. IV

published annually in May

The above publications are available by writing to:

THE REGISTRAR
UNIVERSITY OF SANTA CLARA
SANTA CLARA, CALIFORNIA 95053

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GENERAL INFORMATION

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UNIVERSITY CALENDAR 1969-70*

FALL QUARTER

Sept.	1	Monday	Labor Day, administrative holiday.
Sept.	15	Monday	Registration, School of Law.
Sept.	16	Tuesday	Instruction begins School of Law.
Sept.	17-18	Wednesday-Thursday	Freshman Tests and Orientation.
Sept.	19	Friday	Registration, Graduate. Freshman Registration, A.M.
Sept.	22	Monday	General Registration (Sophomore, Junior, Senior). Graduate Humanities and Engineering instruction begins.
Sept.	23	Tuesday	Undergraduate instruction begins.
Sept.	24	Wednesday	Registration, Graduate School of Business.
Sept.	25	Thursday	Graduate Business instruction begins.
Sept.	29	Monday	Last day for late registration and for the adding of courses.
Oct.	8	Wednesday	Last day for filing for candidacy for graduate degrees to be conferred December, 1969.
Oct.	20	Monday	Last day for seniors to file for candidacy for graduation in 1970.
Oct.	24	Friday	Undergraduate deficiency grades announced. Last day to file petition for Fall Quarter Ph.D. qualifying and field examinations for Graduate School of Business.
Oct.	30	Thursday	Last day to withdraw from courses.
Nov.	19	Wednesday	End of academic pre-planning for Winter and Spring Quarters.
Nov.	27-28	Thursday-Friday	Thanksgiving recess, academic and administrative holiday.
Dec.	1	Monday	Classes resume.
Dec.	9-13	Tuesday-Saturday	Fall Quarter examinations for Undergraduates.
Dec.	16	Tuesday	Fall Quarter grades due.
Dec.	13-Jan. 4	Saturday-Sunday	Christmas Recess.
Dec.	25-26	Thursday-Friday	Christmas, administrative and academic holidays.
Dec.	31-Jan. 1	Wednesday-Thursday	Administrative holidays.

WINTER QUARTER

Dec.	15-19	Monday-Friday	Graduate Engineering Registration.
Jan.	2	Friday	Registration, Graduate Schools of Business and Engineering.
Jan.	5	Monday	Graduate Business and Engineering instruction begins. Undergraduate Registration.
Jan.	6	Tuesday	Undergraduate and Graduate Humanities instruction begins.
Jan.	12	Monday	Last day for late registration and for adding courses.
Jan.	16	Friday	Last day for fulfilling language requirements for graduate degree.
Jan.	30	Friday	Last day to file petition for Winter Quarter Ph.D. qualifying and field examinations for Graduate School of Business.
Feb.	2	Monday	Registration, School of Law.
Feb.	3	Tuesday	Instruction begins School of Law.
Feb.	6	Friday	Undergraduate deficiency grades announced.
Feb.	13	Friday	Last day to withdraw from courses.
Feb.	20	Friday	Last day to file for J.D. degree to be conferred in June, 1970.
Feb.	23	Monday	Washington's Birthday, academic and administrative holiday.
March	2	Monday	Last day to file for candidacy for graduate degrees to be conferred in June, 1970.
March	11-14	Wednesday-Saturday	Winter Quarter Undergraduate examinations.
March	19	Thursday	Winter Quarter grades due for graduate and undergraduate students.
March	15-22	Sunday-Sunday	Spring Recess.

SPRING QUARTER

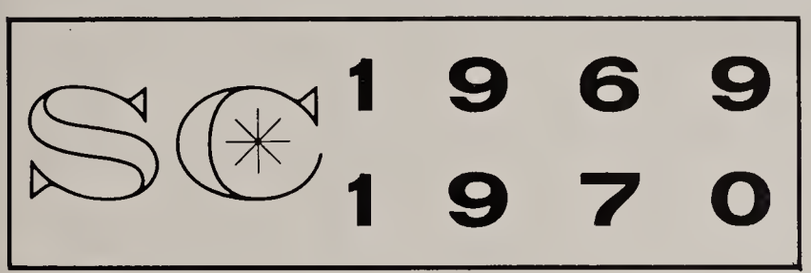
March	20	Friday	Registration, Graduate Schools of Business and Engineering.
March	23	Monday	Undergraduate Registration. Graduate Business and Engineering instruction begins.
March	24	Tuesday	Undergraduate instruction begins.
March	27	Friday	Good Friday, academic and administrative holiday.
March	30	Monday	Last day for late registration and for the adding of classes.
April	17	Friday	Last day for filing with Graduate Committee final draft on theses for graduate degrees to be conferred in June, 1970.
April	24	Friday	Last day to file petition for Spring Quarter Ph.D. qualifying and field examinations for Graduate School of Business.

April	27	Monday	Undergraduate deficiency grades announced.
May	1	Friday	Last day to withdraw from courses.
May	6	Wednesday	End of academic pre-planning for Fall Quarter.
May	20	Wednesday	Last day to file undergraduate pre-registration forms.
May	29	Friday	Memorial Day, administrative and academic holiday.
June	1-5	Monday-Friday	Spring Quarter examinations, Graduate School of Business.
June	3-6	Wednesday-Saturday	Spring Quarter Examinations.
June	8	Monday	Senior and Graduate Humanities and Engineering grades due at noon.
June	13	Saturday	119th Commencement.
June	15	Monday	Spring Quarter grades due.

SUMMER SESSIONS

June	12	Friday	Registration, Graduate School of Business.
June	15	Monday	Graduate Business instruction begins.
June	22	Monday	Summer Session Registration.
August	10-11	Monday-Tuesday	Summer Session examinations for Graduate School of Business.

All dates are inclusive dates.
Undergraduate final examinations always given in first four days of indicated dates.
*Holidays and examination dates listed herein may not apply to the School of Law or the Graduate School of Business. Please consult the Bulletin boards.



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EDWARD J. DALY
SCIENCE CENTER

WHERE TO WRITE

There is a central mail room on the campus to which all mail addressed to The University of Santa Clara, Santa Clara, California (95053) is delivered. Mail for student residence halls must be addressed to their respective locations. It will expedite delivery on the campus to specify the following as indicated.

Correspondence relating to the general interest of the University:
Very Reverend Father President

Communications regarding curriculum, scholastic problems, degree problems:
The Dean of the particular school or the Academic Vice-President

Admission Blanks and Entrance Requirements:
Director of Admissions

Alumni Affairs:
Executive Secretary, University of Santa Clara Alumni Association

Athletic Program:
Director of Athletics

Bulletins and Catalogues:
Director of Admissions

Diplomas and Graduation:
Registrar

Extension and Summer Sessions:
Director of Extension Division and Summer Sessions

Foreign Students:
Director of Admissions

Gifts, Grants and Bequests:
Vice President for Development and Public Relations

Graduate Study:
The Dean of the particular school or college

Honors Program:
Chairman, Honors Committee

Jesuit Faculty Residence:
Father Minister

Personal Welfare and Health of Students:
Dean of Students

Placement:
Placement Office

Publicity:
News Director

Readmissions:
Registrar

Residence Accommodations and Student Housing:
Associate Dean of Students

Scholarships:
Office of Financial Aids

Student Loans:
Office of Financial Aids

Teacher Certification and Placement:
Director of Teacher Education

Transcripts, Student Records:
Registrar

Tuition, Payment of Bills, Refunds:
Comptroller

our concept of Education

The University of Santa Clara is an institution of higher learning founded by the Jesuit Fathers in 1851. The University is governed by a Board of Trustees of laymen and Jesuits.

Its principal objective is to provide superior undergraduate education in the liberal arts and in the sciences, in the professions of business and engineering, to a student body of limited size and of high ability.

It also offers selected graduate programs in business, engineering, law, and humanities and sciences.

It presents programs in theology, scripture, and other religious studies which include the major religious traditions but with emphasis on the Catholic tradition.

It encourages research as an important part of graduate and undergraduate education.

It encourages experimentation and innovation in teaching methods and curriculum to make the education more relevant to contemporary society and the needs of modern man.

It welcomes professors and students of all races, religions, and national origins.

It provides special assistance to disadvantaged students, not only to help solve social injustice, but also to diversify the student body in a way that will better prepare all the students to contribute to a pluralistic society.

Within this diversity it offers the opportunity for spiritual growth in private life and in the Christian community and worship which it fosters.

It is a scholarly community in which students, professors, and administrators, united in the search for truth, are actively involved in the formulation and implementation of institutional policy, and share responsibility for creating and maintaining an atmosphere in which all have freedom to learn, freedom to inquire, and freedom to express themselves.

Santa Clara recognizes the importance of bringing to students, professors and the community at large, current and influential thought from the mainstreams of contemporary life in philosophy, literature, science, the arts, politics, religion and other cultural areas through public discussions, seminars, conferences and exhibitions. These will not necessarily reflect the University position, nor agree with majority opinion, and they will not constitute an endorsement since they may represent divergent views.

Board of Trustees
University of Santa Clara
November 19, 1968

HISTORICAL PERSPECTIVE

The United States of America and the University of Santa Clara had their origins almost simultaneously.

Less than six months after the signing of the Declaration of Independence, near the site of the present city of Santa Clara, the Franciscan padres, de la Pena and Murguia, planted the cross marking the eighth of the original twenty-one California missions. The date was January 12, 1777.

Three-quarters of a century elapsed before Santa Clara College opened its doors as an institution of higher learning, but in the intervening years Mission Santa Clara de Asis had served as a spiritual guidepost and mission school for the Indians.

During this early period, the Mission was destroyed—first by flood and later by earthquakes and fire. The campus surrounds the site of the Mission which was rebuilt in 1822. An adobe structure, which has become the faculty club, was part of the 1822 enclave.

These were tumultuous times for California and for Mission Santa Clara. The first half of the nineteenth century saw it deteriorate from the wealthiest of all the Spanish Franciscan Missions, with thousands of head of livestock and vast lands under cultivation, to several decaying buildings and less than an acre. A combination of factors contributed to the dwindling holdings and diminishing influence of the Mission: first, the Mexican war with Spain, which dragged on from 1810 to 1821, eventually resulted in a decree that all Spaniards must leave Mexican territory. Even though it took years for the order to reach Mission Santa Clara, the Spanish Franciscans were finally replaced with Mexican Franciscans in 1833.

The Mexican padres did their best to maintain the vast holdings, but the money from crops and livestock, the "pious fund" used to operate the Missions, was under constant threat of confiscation by the new government. The lands were to be returned to the Indians, who had little talent for farming.

Nevertheless, the "Garden of the World," as the Santa Clara Valley was known, offered great attraction to American settlers, and by the time California had been won from Mexico in 1848, the area had been heavily repopulated. The Gold Rush, begun by the discovery at Sutter's Mill, briefly decimated the population again, but stability shortly returned to the area, and by 1849 the State Constitution was ratified and San Jose enjoyed a brief moment of early glory as California's first capital when California was admitted to statehood in 1850.

This was the setting in which the new Santa Clara College was established a year later. The Right Reverend Joseph Sadoc Alemany, O.P., the new Bishop of the San Francisco Diocese, recognized the need for an institution of higher learning to serve the growing popula-

tion and determined, at the same time, to save the historic, decaying Mission.

With only $150 and some inspiring words of encouragement, John Nobili, a Jesuit priest, was asked to become pastor of the Mission and to start a college. What Nobili that year had termed ". . . the germ only of such an institution as we would wish to make it and as the wants of the community will require . . ." has grown into a full-fledged university with total assets of more than $55,000,000 and a budget of some $10,000,000 annually.

But when Santa Clara College opened its doors more than a century ago, a faculty of two taught sixteen students. Just three years later, the faculty outnumbered that first student body, and 102 students were enrolled. And then as now, in the words of Nobili, ". . . it is a Catholic school, yet those of other Faiths are admitted also, and their religious opinions are not interfered with. . . . To cultivate the heart . . . a care of morals, no less than intellectual improvement, are duties kept sacredly in view. . . ."

The fortunes of the "Mission School" were inextricably tied up with those of California. Reflecting the needs of the times, when the state was filled with prospectors and farmers, the opinions of the Departments of Metallurgy, Agriculture and Horticulture were much sought after as arbiters of final authority. With time, these have passed into history, and new departments have sprung up to take their place.

The College grew and prospered. It waited until just before World War I before it felt it had merited the title "University" with which it had been chartered in 1851. The new name was coincident with the founding of the Colleges of Engineering and Law, which had previously been departments offering a handful of courses.

In 1926, a College of Business Administration opened its doors as the University reflected the urban growth around it and presaged a transition from agriculture to industry yet to come.

The period before World War II was one of relative stability. Ricard Observatory was built, and the new Bergin Hall opened its doors to law students for the first time. It was a time when Santa Clara became a football power, and a "Bronco" athletic tradition was born.

When the veterans of World War II returned to campuses all over the country, the University and the San Francisco Bay Area were on the threshold of a new era. A tremendous population influx had begun, and, with it, industrialization dramatically increased its tempo.

Student enrollment has more than tripled since World War II—from 880 to 2960 undergraduates. In the Fall of 1968, graduate students, a relatively new group since the mid-1950's, numbered about 2200.

THE CAMPUS

Santa Clara's campus has grown almost as dramatically as its enrollment in the decades since World War II. An increasing number of its new buildings are being placed across El Camino Real (or "King's Highway") opposite the original campus. Buildings now cover sixty-seven acres.

In the first postwar decade, a new administration building; two dormitories, Walsh and McLaughlin Halls; and de Saisset Art Gallery were built with private funds. Later, the first three units of the Sullivan Engineering Center were completed and a Law Library was added in 1963, a gift of Edwin A. Heafey.

In addition to several dormitory buildings, recent additions have included the Robert F. Benson Memorial Center for students, completed in 1963; the Michel Orradre Library, which opened in the summer of 1964; and the Edward J. Daly Science Center, which was completed in early 1966. The tallest building on campus, Swig Hall, a men's dormitory of eleven stories and a capacity of 466, also opened in 1966. Kenna Hall was completely refurbished in 1967 into modern classroom, lecture and office facilities for the Schools of Business.

Through the blending of early Spanish Colonial architecture with modern convenience and utility, the campus has lost none of the serenity or charm with which it was originally endowed well over a century ago. The well-kept lawns and lush gardens reflect the richness of the soil and the temperate climate of the Santa Clara Valley. The campus is set with immense redwoods, includes spruces, sycamores and olive trees, and is lined with tall date palms.

LOCATION

The University of Santa Clara is 46 miles from San Francisco near the southern tip of the Bay. Railroad and bus and car transportation by freeway places the renowned cultural and entertainment centers of San Francisco, Berkeley, Oakland, and Marin County within one hour's travel. In the opposite direction are the beaches of Santa Cruz, and less than two-hours drive from the campus is the world-famed Monterey Peninsula and Carmel.

The University is accessible by all major railroads, by major airlines via San Francisco and Oakland International Airports, and by United Airlines, Pacific Southwest Airlines, Air West and Air California at San Jose Municipal Airport—about three miles from the campus.

UNIVERSITY ACCREDITATIONS AND MEMBERSHIPS

ONE HUNDRED and NINETEENTH YEAR
1969-70

Member National Catholic Educational Association
Member Jesuit Educational Association
Accredited by the Western Association of Schools and Colleges
Member American Council on Education
Member Council of Graduate Schools in the United States
Accredited by Engineering Council for Professional Development
Approved by the American Bar Association
Member Association of American Law Schools
Approved by the American Medical Association
Accredited by the American Chemical Society
Accredited by the State Bar of California
Accredited by American Association of
Collegiate Schools of Business
(Undergraduate and Graduate Programs)
Member Conference of Jesuit Law Schools
Member Conference of Western Law Schools
Member of College Entrance Examination Board
Member of Association of American Colleges
Accredited by California State Board of Education
Institutional Member of the American Mathematical Society
Member of The American Association
of Colleges for Teacher Education
Member American College Public Relations Association
Member American Alumni Council

THE UNIVERSITY OF SANTA CLARA
Santa Clara, California

THOMAS D. TERRY, S.J.
President

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OF SANTA CLARA COLLEGE

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THE SANTA CLARA PLAN

The academic calendar and curriculum has undergone an extensive reorganization at the University. Instituted in the Fall of 1964, its aim was both to simplify and to strengthen a student's program.

Briefly, the Santa Clara Plan divides the academic year into three eleven-week terms and limits the number of courses a student takes each term to three or four.

The Plan is a variation of the "Three-Three" method of education which is a recent innovation in other outstanding liberal arts colleges. "Three-Three" simply means a student takes three courses in each of three terms.

The most important departure from the "Three-Three" plan is that freshman and sophomore students will take four courses at most each term, instead of three. They may take a minimum of twenty-two lower-division courses. This addition was designed to ease the student's transition from high school and to help him establish effective study habits before he reaches upper-division work. In his junior year, he will enter the standard "Three-Three" program, taking only three courses per term, which will require a marked degree of independent study on his part.

Each student's classes will meet four times each week on Monday, Tuesday, Thursday, and Friday. When he graduates, each student will have taken a minimum of forty courses and a maximum of forty-two, all of equal length. The unit system of credit traditionally used has been eliminated, and the student is able to concentrate on a few subjects at a time in depth. Under the traditional system, he would have taken approximately twice as many courses at any given time.

The Santa Clara Plan affords the opportunity for each student to supplement classwork by independent, but directed, research to the end that both the quality and the scope of his education is enhanced.

DEPARTMENTAL HONORS PROGRAM

The Departmental Honors Program is designed to meet the University's responsibility to its superior students by allowing them to pursue an Honors curriculum while majoring in any field. Lower division study for Honors students is a combination of seminars, limited to 10 or 12 students, and lecture courses which presuppose work beyond the usual high school level. In junior and senior years Honors students work intensively in their areas of specialization. Much of their upper division work will be in seminars and directed research. Honors students are less strictly bound by general University requirements and various Pass-Fail options encourage better use of electives outside their major fields. Special counseling opportunities and registration privileges are available for Honors students which enable them to create the curricula best suited to their abilities, preferences and future professional needs.

Toward the end of their freshman year, Honors students who have demonstrated exceptional academic responsibility are designated Honor Scholars, are released from all University requirements, and are permitted to follow a personalized program of studies during their next three years. Honors Scholars are chosen and counseled by a committee made up of their Dean, Department Chairman, and the Chairman of the Honors Committee.

Students are considered for admission to the Honors Program on the basis of their high school records, Scholastic Aptitude Test scores, letters of recommendation, and expressed interest. About thirty freshmen are accepted into Honors each year. A 3.50 high school grade point average and a 1350 SAT total score (including a 650 Verbal score) are the ordinary requirements for acceptance into the program. All incoming Honors freshmen are considered Candidates for Honors and are accepted into full Honors status during the Spring Term of the freshman year after two terms of successful Honors performance. To remain in the program, students must satisfy their instructors that they are doing work of Honors caliber as well as maintain a 3.0 cumulative grade point average. Final admission to candidacy as well as to full Honors status is determined by the Faculty Honors Committee.

DIVISIONS OF THE UNIVERSITY AND CURRICULA

Santa Clara offers varied undergraduate and graduate curricula. In the three undergraduate colleges the programs are:

- *College of Humanities* —

  Education, English, French, German, History, Italian, Philosophy, Spanish, Theatre Arts, Theology. Honors in most of the preceding areas.

- *College of Sciences* –
  Biology, Chemistry, Economics. Mathematics, Physics, Political Science, Psychology, Social Science, Sociology. Honors in several of these major fields.

- *School of Business* –
  Accounting, Economics, Finance, Marketing, Management, and Statistics.

- *School of Engineering* –
  Civil, Electrical, and Mechanical Engineering and Applied Mathematics.

Post-graduate and professional programs are offered in the following schools:

- *School of Law* –

- *School of Theology, Alma College*–

Graduate and professional programs are offered in Business, Engineering, English, History, Education, Teacher Education, Law, and Theology.

SCHOOL OF THEOLOGY

Alma College, the school of theology of the California and Oregon Jesuit Provinces, is affiliated and accredited with the University as its School of Theology.

Registration is at present limited to members of the Society of Jesus in preparation for the priesthood.

THE COLLEGES OF HUMANITIES AND SCIENCES

Liberal education is the sort that "enables each man to think as well as his native powers permit." This liberal education is composed of experience in the humanities, mathematics, natural sciences, social sciences, philosophy, and theology, and is designed to provide general enlightenment about nature and man. Because this enlightenment is indispensable to a rich human life, the curricula of the Colleges of Humanities and Sciences satisfy both the student certain of his or her future career choice and the student seeking a broad educational experience before making such a choice. For the former, the Humanities and Sciences curricula includes preparation for a variety of professional training and for graduate education.

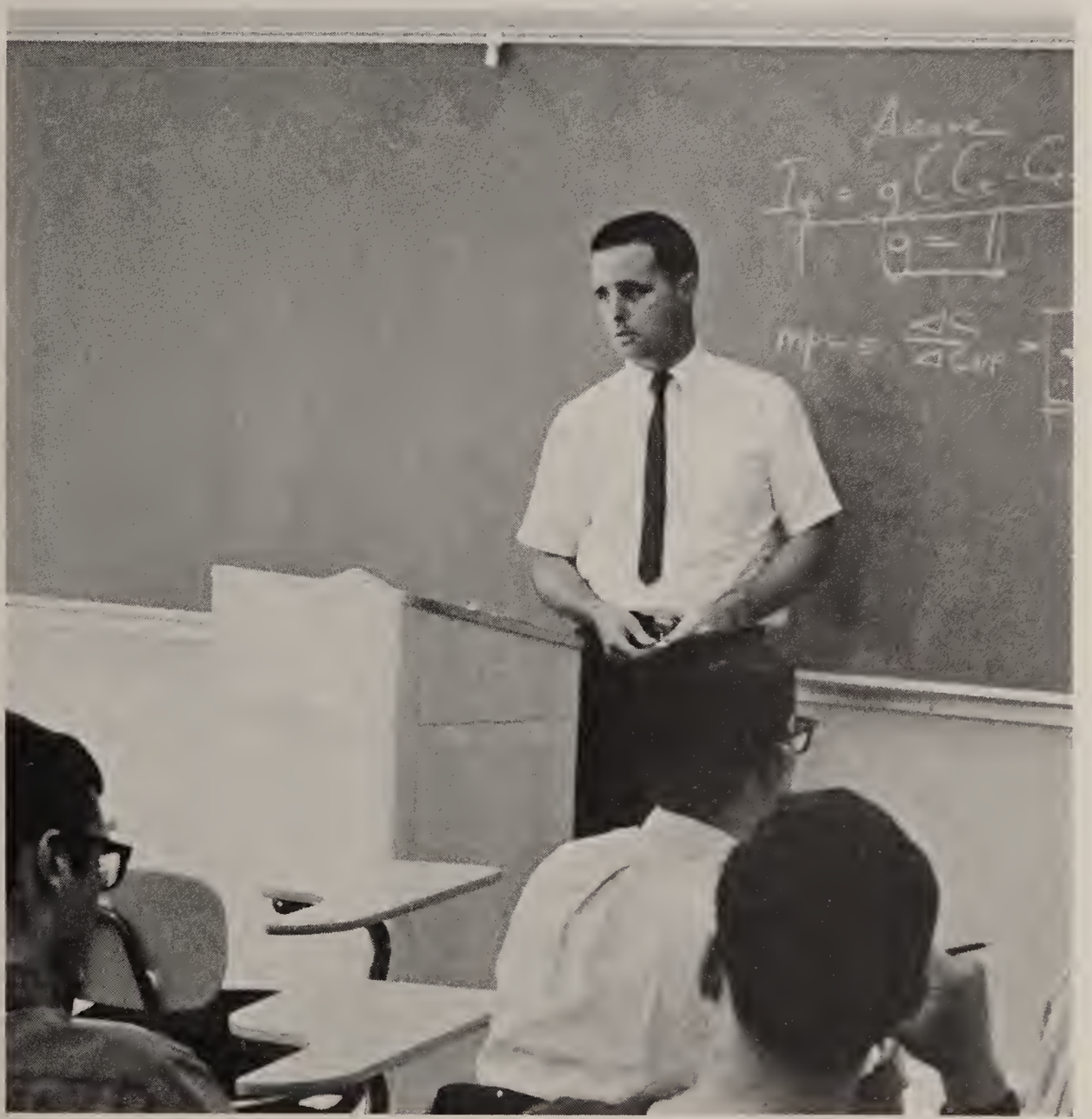
THE SCHOOLS OF BUSINESS

The primary objective of the Undergraduate School of Business is to supply professional training for those who are aiming at responsible positions in corporations, their own business, professional organizations serving business, and governmental agencies.

Cases, problems, and discussions supplement the lecture method of instruction, and in the student's first two years, the fundamentals of English, mathematics, economics, accounting, speech, and philosophy prepare him to analyze and study the technical and special problems of business. During the junior and senior years, the program is arranged so that every student will include study in the major business functions.

Courses in ethics, philosophy, and science provide the student with the broad principles necessary for dealing with the industrial system in its social relationships.

In the Graduate School of Business the Master of Business Administration and Doctor of Philosophy Degrees are offered.



THE SCHOOL OF ENGINEERING

Beyond an undergraduate program in Engineering, a wide range of opportunities exists in the profession of engineering. This vista is becoming increasingly broad because of the rapid expansion of technology in today's society, and the influence of technology on many activities in business and industry.

At Santa Clara, programs are available in civil engineering (relating to structural and sanitary works and works which have to do with water and transportation), mechanical engineering (concerned with propulsion, power generation, explosions of all types, heating, refrigeration and air conditioning, and structure subject to motion), and electrical engineering (design, construction, and operation of equipment for generation, transmission, and utilization of electrical energy).

Since its inception, the School of Engineering has felt that the undergraduate program primarily must include course work which is considered fundamental to all engineering with a minimum of specialization in the separate branches.

THE SCHOOL OF LAW

The School of Law has as its objective the preparation of men and women for the legal profession. The program stresses the development of professional responsibility and the perfection of legal skills. This involves not only the acquisition of a working knowledge of the principles of law but also the training of the student to "think like a lawyer." A basic technique in this education is the case method, in which the student is confronted with actual problems in the law and is assisted in learning how to solve them in a systematic and professional way.

FOREIGN STUDIES

Because of many cultural and academic advantages, Santa Clara students are encouraged to spend their junior year abroad. Through the University's affiliation with the Institute of European Studies, students may study at Freiburg, Madrid, Nantes, Paris or Vienna. One year of language study or a demonstrated competence in the language is required to participate in this program. Santa Clara credit is given for work done at any of these campuses. In addition, the University is also affiliated with the Loyola (Chicago) Rome campus. To enroll in any of these programs, the approval of the Director of Studies Abroad is required.

SUMMER SESSION

The Colleges of Humanities and Sciences, in a single six-week session, offers day *and evening* classes for college credit. Men and women, lay and religious, are welcome in all departments. No transcript is required for admission. Courses are scheduled in art, business (undergraduate), economics, education, English, history, language, mathematics, music, philosophy, political science, psychology, sociology, speech, and theology. Graduate courses applicable to a master's degree are offered in education, English, and history.

Institutes and workshops of one, two and three weeks duration are presented in education, counseling, creativity, writing, political and social science. Special non-credit courses include data processing, rapid reading, study skills.

Advanced placement for high school students permits high achievers who have finished the eleventh grade to enroll for university credit in freshman level courses and in intermediate languages. Recent graduates of high school are also eligible to enroll.

Board and room are available for men and women, lay and religious, at reasonable rates in the University's attractive dormitory settings.

The Summer Session Office is in Room 5, Administration Building, phone 246-3200, extension 205 and 206.

Evening courses in the Graduate School of Business and in the School of Law, as well as early-morning graduate courses in the School of Engineering, are separately administered. Information concerning these is obtainable from the appropriate schools.

A two-week coaching camp for boys aged 9 to 14, with on-campus housing if desired, is directed by the Athletic Department.

EXTENSION DIVISION

Through the Extension Division the University makes its facilities available for the continuing education of the general community. Evening classes on the undergraduate level are offered in humanities and

in business-related areas. Courses include art, teaching methods, literature, languages, history, mathematics, psychology, rapid reading, memory training, speech, theology; also data processing, personnel and business management, income tax, traffic and transportation.

Classes are open to all who can profit from them. No transcripts are needed. Extension courses are not acceptable for credit as part of a degree program at the University of Santa Clara because no prior academic screening is required. The caliber of the Extension faculty and courses is such, however, that an increasing number of teachers enroll to gain points for salary increment and to heighten their classroom competency. Professional persons from business and industry, as well as war veterans, can be reimbursed for successful completion of these courses; these should make prior arrangement with their sponsoring organization.

Other enrollees include men and women who wish to "try themselves out" in a university or reintroduce themselves to university courses without being formally admitted to a degree program; students who need review work and preparatory courses; other discerning adults who desire to advance professionally, to update themselves, and to keep growing intellectually and culturally.

Permanent records of Extension grades are kept in the Registrar's office. Information about extension courses is available in Room 5, Administration Building, phone 246-3200, extension 205 and 206.

MICHEL ORRADRE LIBRARY

In August, 1964, the holdings of the Varsi Library were transferred to the new and spacious Michel Orradre Library, named in honor of one of the principal donors, the Orradre Family.

The new building, as completed to date, will hold 300,000 volumes and is designed to contain 600,000 volumes when further installations are made in the partially completed lower level.

As in the former Varsi Library the open shelf plan is continued in the Orradre Library with special service areas grouped around the central core of the edifice. The Library is an official depository for both California State and United States Government Documents.

The Library is open seven days a week for a total of 99 hours per week for the convenience and assistance of faculty, graduate and undergraduate students.

On the fourth of September 1966, the holdings of the Michel Orradre Library in Biology, Chemistry and Physics were transferred to the new branch Science Library in the new Edward Daly Science Center. Named after Mr. Frank Gentles, this collection will service the science departments in the immediate area for study and research.

INFORMATION ON ADMISSIONS

Requirements

The following high-school courses are required of students applying for admission to the University as freshmen:

Course	Number of Units: *Humanities and Business Majors*	*Science and Engineering Majors*
Algebra	1	2
English	3	3
History	1	1
One foreign language	2	2
Plane geometry	1	1
Laboratory science	1	2**
Trigonometry	—	½
Optional*	7	4½
Total	16	16

* *Optional courses must be in advanced foreign language, mathematics, laboratory science, or other solid college-preparatory courses.*

** *Chemistry and Physics.*

ADMISSION PROCEDURE

The prospective student should:

1. File his application and service fee of $15.00 with the Admissions Office, University of Santa Clara. (Application forms may be obtained from that office.)
2. Submit personal evaluation form (to be completed by an official of his school) to the Admissions Office. Form accompanies application papers.
3. Request his high school to send a transcript of his work immediately after the fall semester of his senior year to the Admissions Office, University of Santa Clara.
4. Take the Scholastic Aptitude Test and the English Composition Test of the College Entrance Examination Board and request that test scores be sent to the University of Santa Clara. In addition to the SAT, students applying for Chemistry, Physics, Mathematics, and Engineering must take achievement tests in Math – Level I, Chemistry and Physics. Information on locations and dates of these tests can be obtained by writing College Entrance Examination Board, Box 1025, Berkeley, California 94701, or Box 592, Princeton, New Jersey 08540.
5. Make sure all of the above are completed and in the hands of the Admissions Office by March 1. Late applications will be accepted if possible, but full consideration cannot be guaranteed. *(Application deadlines for transfer and graduate [Humanities] students are: Fall Term—August 1; Winter Term—December 1; Spring Term—March 1.)*

Early Decision Plan

Students who have earned a 3.5 out of 4.0 average in the first three years of high school may apply for admission, after their sixth semester. Their applications should specifically state their request for early decision and should be accompanied by transcripts and personal evaluation. College Board scores should be submitted during the junior year or in the summer before the senior year.

Advanced Placement

The University is a participant in the advanced placement program of the College Entrance Examination Board. Students desiring consideration for such placement or credit should take the College Board Advanced Placement Examinations given in May of each year. On re-

ceipt of the scores on these examinations, and other evidence presented in this procedure, action will be taken and notification will be sent to the applicant, usually in August preceding the enrollment.

Admission of Foreign Students

Candidates for admission who come from foreign countries must, in addition to the Scholastic Aptitude Tests (required of *both* freshmen and transfer applicants), present a score in the Test of English as a Foreign Language, given by the Educational Testing Service. This test is administered on several dates during the year, at test centers throughout the world. Information and applications for this test may be obtained by writing: Test of English as a Foreign Language, Educational Testing Service, Princeton, New Jersey, U.S.A. 08540. In order to be issued Immigration Form I-20, applicant must be accepted as a full-time credit student working for a degree.

Admission of Special Students

Students not having entrance requirements may be admitted as special students if they are persons of mature age whose experience and test results reflect the ability to do college work. No one will be admitted directly from a secondary school to the status of special student except in extraordinary cases.

Such special students are not candidates for a degree, but they may become candidates by doing satisfactory college work. Registration is for one or two terms. At the end of that time they either discontinue their work or become regular students.

Admission to Advanced Standing *(Transfers)*

Transfer students who were acceptable for admission as freshmen to the University at the time of their graduation from high school may be admitted to advanced standing if they have at least a 2.0 grade-point average in transfer courses at the last college attended and an over-all 2.0 grade-point average in all transfer courses attempted. Proof of eligibility, as above described, must be supplied by the applicant.

Students who, for academic reasons, were not acceptable for admission as freshmen at the time of graduation from high school may be admitted to advanced standing if they have completed, in any approved college, at least 30 semester units of transfer courses with better than average grades.

Readmission

Former students of the University who wish to re-enroll must apply for readmission. To do this, students who have not attended another

college or university since they last attended Santa Clara should file an application with the Office of Admissions, indicating their activities during their absence from Santa Clara. Students who have attended another institution in the interim should follow procedures for transfer applicants: submit an application form, recommendation forms, and transcripts of all work done since they last attended Santa Clara.

Deadlines for applicants for readmission, in both cases covered above, are same as for transfer applicants: Fall term—August 1; Winter term—December 1; Spring term—March 1.

Graduate Admissions

For information on admission to graduate work, write to the dean or the director of the graduate division, or school, involved.

Degree Requirements

Degree requirements in the various curricula are found in the appropriate sections of the catalog. Besides the subject matter requirements, the undergraduate colleges and schools and divisions demand at least an over-all C average and, in addition, a C average in the courses of the major.

Costs

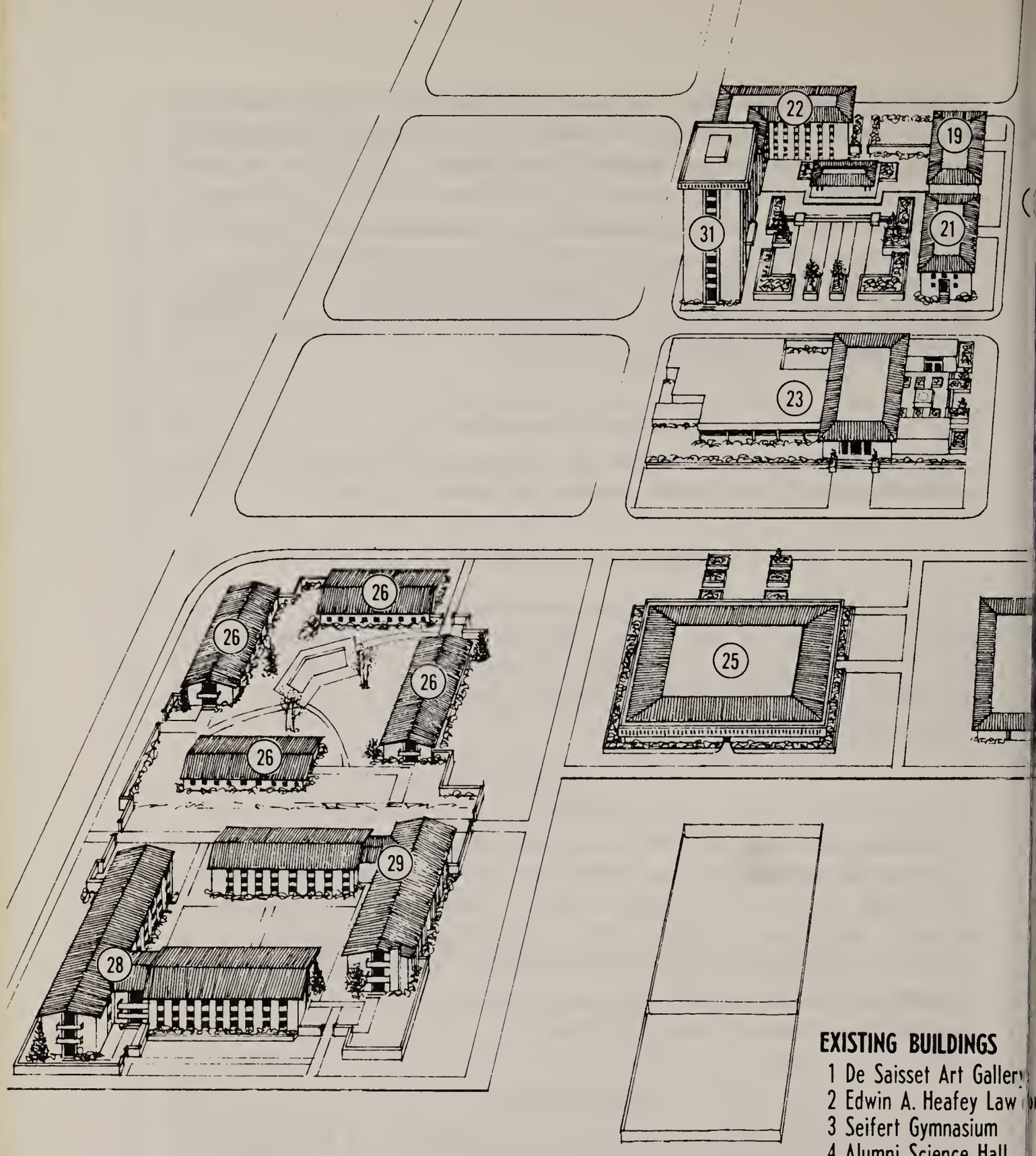
Tuition totals $1,725 for the three-term academic year. Students who live on campus pay an additional $1,065 for meals and housing. Additional expenses of perhaps $600 a year would include books, laundry, and other essentials. The expenditures for clothing, social activities, transportation, and other needs are commensurate with the appetites of the individual. Specific University fees are tabulated in Section II, page 43, of this publication.

Financial Aids

Financial assistance at the University of Santa Clara is awarded on the basis of demonstrated leadership and character, superior academic record, and financial need. Assistance generally is categorized as scholarships, loans, deferred payment plans, and jobs. Please refer to the section on Undergraduate Regulations for details concerning Financial Aids.

Graduate Financial Aids

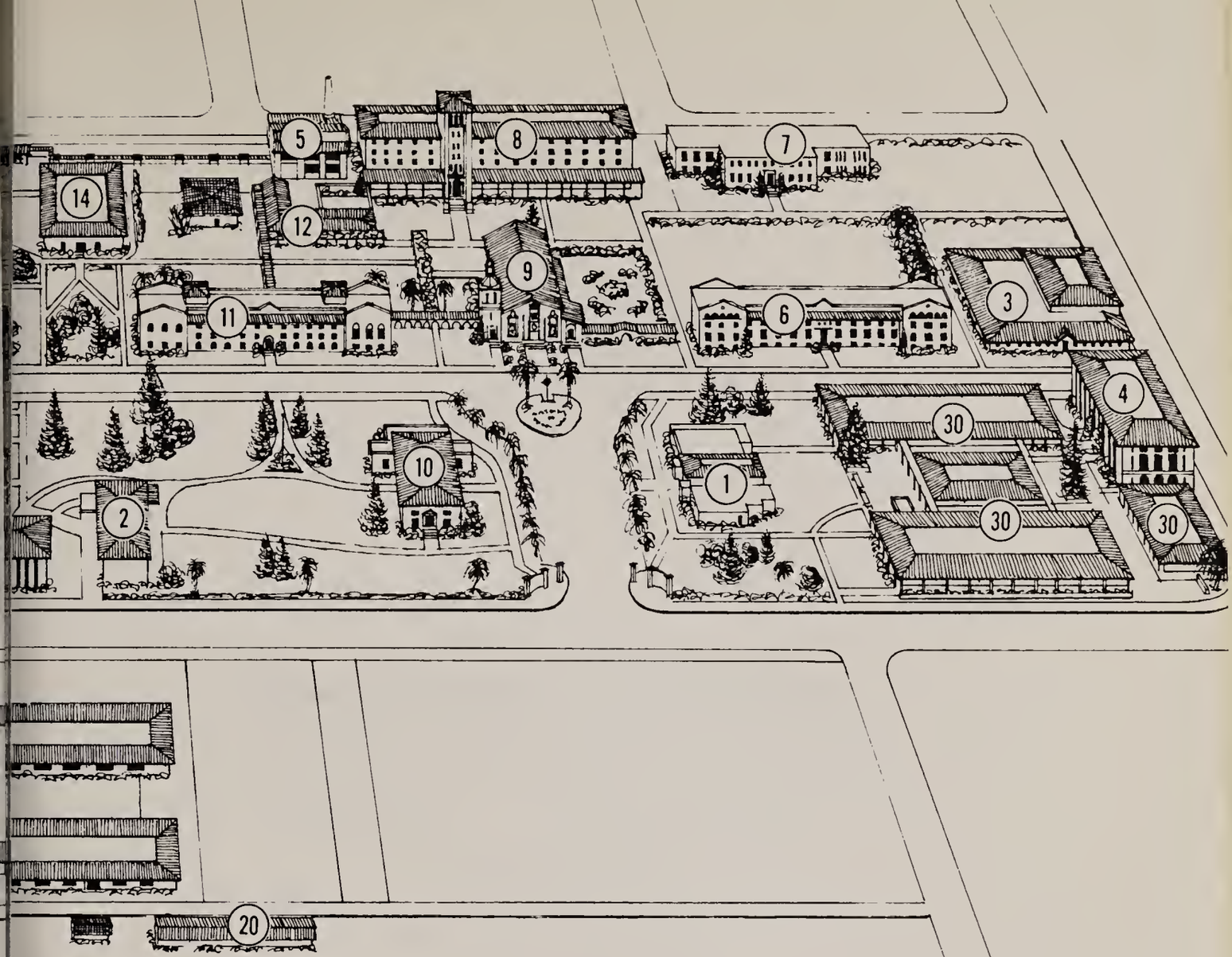
Inquiries regarding assistantships, fellowships and scholarships should be addressed to the Dean of the school concerned.

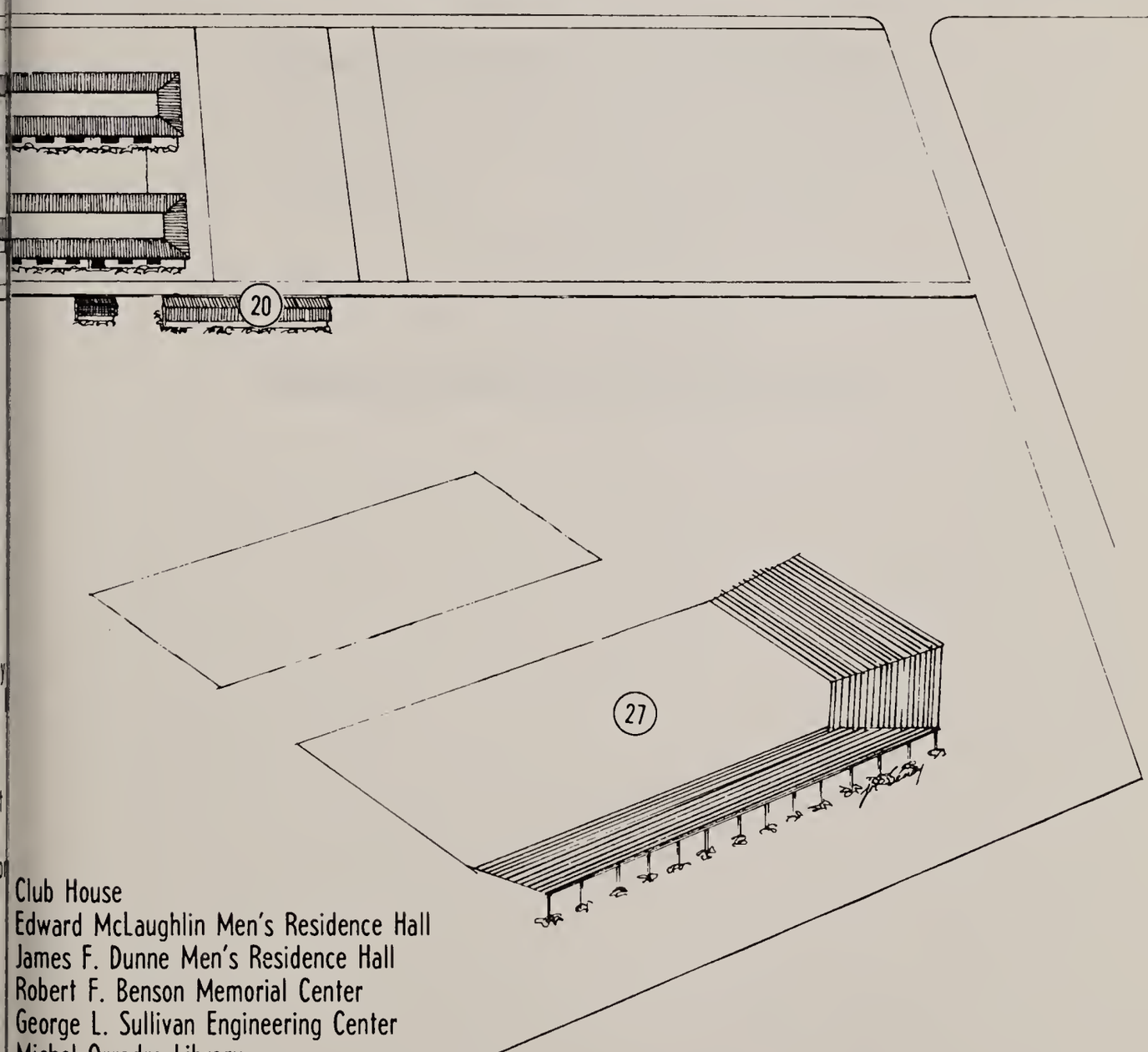


THE UNIVERSITY OF SANTA CLARA

EXISTING BUILDINGS

1 De Saisset Art Gallery
2 Edwin A. Heafey Law
3 Seifert Gymnasium
4 Alumni Science Hall
5 Central Heating Plant
6 O'Connor Hall
7 Montgomery Laborato
8 Nobili Hall
9 Mission Church
10 Delia Walsh Hall
11 Faculty Residence
12 Adobe Lodge
13 Service Buildings
14 Varsi Library
15 Donohoe Infirmary
16 Ricard Observatory
17 Kenna Hall
18 Bergin Hall
19 James Walsh Hall





Club House
Edward McLaughlin Men's Residence Hall
James F. Dunne Men's Residence Hall
Robert F. Benson Memorial Center
George L. Sullivan Engineering Center
Michel Orradre Library
Charles Graham Women's Residence Center
Buck Shaw Stadium
Women's Residence Hall Stage No. 1
Women's Residence Hall Stage No. 2
Edward J. Daly Science Center
Swig Residence Hall for Men

SECTION II

UNDERGRADUATE REGULATIONS

EXPENSES • SCHOLARSHIPS

STUDENT LIFE

MILITARY SCIENCE

COURSE REQUIREMENTS

The undergraduate program is scheduled on a basis of three eleven-week terms per academic year of nine months. The eleventh week will be devoted to examinations. During the freshman and sophomore years the student schedules four courses per term, or a minimum twenty-two courses all told, and he schedules three courses per term during his junior and senior years. These forty courses in four academic years is the requirement for the Bachelor's degree in all departments.

Classes are normally scheduled on Monday, Tuesday, Thursday, and Friday. The Santa Clara plan of academic performance envisions considerable independent study by the students. Wednesday will be kept free of laboratories, examinations, and seminars, to provide uninterrupted study periods. No student activities will be scheduled prior to 3:00 P.M., except military drill at 9:00 A.M.

No lower-division student may carry less than three courses per term without the approval of his Dean. No lower-division student may carry more than four courses per term. No upper-division student may carry less than two term courses without the approval of his Dean. No upper-division student may carry more than three term courses, except under the following conditions:

1. He must have a 3.3 G.P.A.
2. He must have a letter from the Dean permitting him to do this.
3. The purpose of extra courses is enrichment and not reducing the time necessary for graduation. Consequently, an extra course, while it may satisfy a course requirement (e.g., Language) does not satisfy the requirement of 40 courses for graduation. In other words, a student who takes an additional course must have 41 courses to graduate.

Juniors and seniors may, with authorization, take a fourth course in any term on a pass-fail basis. The grade of C or above is passing and D or F is failing.

Any upper division student who takes a fourth course without authorization will be denied credit for it.

A sophomore may take an upper-division course if approved by his dean and provided his program does not exceed four courses.

To relate the term-courses system to other systems of credit, lower-division courses which are taken four at a time are considered equivalent to a four-quarter-unit course, and courses taken in the upper division, three at a time, are equivalent to a five-quarter-unit course.

A part-time student is defined as a lower-division student taking less than three term courses, and an upper-division student enrolling in fewer than two term courses. A full-time student who drops courses during the course of a term will be considered full-time for the balance of that term.

MARKING SYSTEM

A student's grade of scholarship is given according to the following marks:

A	Excellent	F	Failure
B	Good	I	Incomplete
C+	Above Average	W	Withdrawal
C	Satisfactory	W/F	Withdrawal failing
D	Inferior	W/P	Withdrawal passing

A student must earn a C average in all work undertaken and, in addition, a C average in the courses of his major in order to qualify for the Bachelor's degree. To determine a numerical average, 4 grade points are assigned for each A, 3 for a B, 2.5 for a C+, 2 for a C, 1 for a D, and 0 for an F. To arrive at the grade-point average, the total earned grade points are divided by the number of courses which have been undertaken. A C average is 2.0.

REPETITION OF COURSES

A student may, with permission, repeat a course in which a grade of D or F was received on the first attempt. He should use the letter R in registering for the course again. All grades, whether repeated or not, will be used in computing the student's performance.

WITHDRAWING FROM COURSES

Students may withdraw from courses without penalty within one week following notification of midterm grades.

ENTERING NEW COURSES

Students may enter a course for the first time only during the first week of classes of the term.

TRANSFER CREDIT

Students who transfer a specific course to the University from another institution will not accumulate credit for these courses unless they are accumulated in sufficient quantity to total the quarter unit equivalent of a term course.

The student's grade-point average is computed only on work done at Santa Clara. Collegiate work at another institution with a grade of C or better may be transferred to Santa Clara and counted in fulfillment of graduation requirements, but it will not be counted in determining the student's grade-point average and rank in class.

INCOMPLETES

A student's work may be reported incomplete if, due to unavoidable circumstances, some essential portion of his work in the course remains unfinished after the final examination. An incomplete becomes a failure unless the unfinished work is completed to the satisfaction of the instructor within a period of one year.

ACADEMIC PROBATION, SUSPENSION, DISQUALIFICATION, REINSTATEMENT

Probation

Freshmen and sophomores are placed on probation if they are 3 grade points below C.

Juniors and seniors are placed on probation if they are 2 grade points below C.

A student 4 or 5 grade points below a C will be suspended in June. If he is improving in the Spring term, the number would be 5. If his work is poorer in the Spring term, the number would be 4.

Suspension

A student who remains on probation two terms without making up one grade point per term is subject to suspension for up to one year. A student who returns after suspension and does not reduce his deficiency by one grade point per term will be disqualified. No student may be suspended twice.

Disqualification

Normally, students are disqualified only after they have returned to the University following an academic suspension and again go on academic probation. At the discretion of the Dean of the School, a student may be permanently disqualified without previous probation, or suspension, for unsatisfactory academic performance.

A student who has been disqualified is excluded from further attendance at the University and is permanently disbarred therefrom.

A student who does not have an overall C average and a C in his major at the beginning of his final term will not be permitted to graduate at the end of that term, no matter what his grades may be during that term.

Reinstatement

A student who has been academically suspended from the University may not be readmitted except after the lapse of the period for which he was suspended and through the special action of the Committee on Admissions. To obtain readmission he must write a letter to the

Committee informing them of this fact, and if he has spent the intervening period in another institution, he must present grades of such quality as to give promise of success in the remainder of his college work. His status if readmitted will be "probation."

WRITTEN EXAMINATIONS

Written examinations are held at the middle and end of each term. A report of the student's progress is prepared by the Registrar's office and mailed to his parents only at the end of the term. Students earning a D or F at the mid-term will be notified.

A student guilty of dishonesty in an examination will be given a failure for the course. In special cases, the administration may impose the penalty of dismissal from the University.

WITHDRAWAL FROM THE UNIVERSITY

When a student withdraws from the University, he must report to the Registrar for a Withdrawal Form and complete the necessary procedure under penalty of receiving Fs for all incompleted courses.

CHALLENGING COURSES

A course is said to be challenged when a student takes a special examination in the course for the purpose of obtaining credit for it. He may prepare for this procedure by directed independent study.

Any course in the catalog may be challenged except those specifically identified in the catalog as exempted from challenge (indicated by the letters NCX) and those requiring laboratories.

To challenge a course, a student must have a 2.2 cumulative average and a 2.5 average in his major field. Freshmen and transfer students are not eligible to challenge a course until they have completed one term of work at Santa Clara. A student desiring to challenge a course should obtain a form from the Office of the Registrar on which he will identify the course as well as any course he has previously audited or challenged. He must then receive approval from an instructor in the department and the Dean of his School. A fee of $10.00 will be charged for each course challenged.

Normally the examinations for challenging courses will be given on the third Saturday of each term. The petition for challenging a course must be submitted at least two weeks before the examination date.

Grades will be issued for challenged courses in the same manner as those obtained through regular course work. Courses successfully challenged will fulfill graduation requirements but will not count towards the forty required for graduation. Challenged courses may not be

used in the performance of residence requirements. The department shall establish the level of performance to be obtained and any requirements in addition to an examination which will be three to four hours in duration.

AUDITING COURSES

Only students who have maintained a B average in the University, may audit a course. These students may audit one course in addition to the three courses they take in the upper division, or the four courses taken in lower-division work. A student may not enroll as a course auditor and then decide to take the final examination for credit. If he wishes credit for an audited course, he may challenge the course during the following term by following the regular challenging procedure.

Students who are not full-time students must pay $125.00 per course for auditing. A student may not audit more than three courses during his four years at Santa Clara.

ATTENDANCE

Students are required to attend all classes. Penalties for absences are left to the discretion of individual instructors.

GRADUATION

The requirements for graduation can be summarized as follows:

1. Complete a 40 term-course program approved by the University as meeting the requirements for the particular degree. If a freshman or sophomore receives an F in one of his courses, he may still graduate without repeating the course, if the grade were not gotten in a required course and providing he has a C average overall and a C in his major as usual. He shall then have taken 40 courses and passed in 39 of them. This rule does not permit a student to graduate with 39 courses even though he has not failed in any of them.
2. Achieve an overall academic performance level of a C which is a 2.0 numerical average.
3. Obtain a C average in the courses of the major.
4. Complete the residence requirement of at least seven term courses normally in the year immediately preceding the awarding of the Bachelor's degree. Transfer students who attend the university only in their senior year shall complete nine term courses as a residence requirement.
5. Satisfy the American History and Institutions requirement by examination (not for credit) or by courses completed at this or another University.

GRADUATION HONORS

A candidate for an undergraduate or professional degree who has a grade-point average of 3.40 graduates Cum Laude; one who has a grade-point average of 3.65, Magna Cum Laude; one who has a grade point average of 3.85, Summa Cum Laude. Graduation honors are based on the work of the four years.

CHANGING COURSES, MAJORS, SCHOOL OR COLLEGE

Certain administrative procedures for changing course registration, changing majors within a College or School, or changing from one School to another must be observed or the student will be incorrectly charged, to the possible detriment of his academic record. The necessary forms and procedures may be obtained from the Office of the Registrar.

RIGHTS RESERVED

The curriculum and regulations affecting students may be revised at any time at the discretion of the University administration.

STUDENT EXPENSES
1969-70

Application Fee ..... $ 15.00
This charge is to be sent with each application form and is not refundable.

Deposits:

All new students or students re-applying for admission .... $ 100.00
This amount is automatically credited to the student's account at registration or at the time of full-tuition payment. This deposit is not refundable.

All returning undergraduate students must make the deposits indicated below by *May 31st.*

A deposit of $100.00 is required of all returning *boarding students* ..... $ 100.00

A deposit of $50.00 is required of all returning *day students* ..... $ 50.00

These deposits are not refundable after *June 30th.* Transfer from boarding to day student status after this date will result in forfeiture of $50.00 of the deposit.

Tuition per Quarter ..... $ 575.00

Part-Time Student Tuition, 1 course ..... $ 230.00

2 courses ..... $ 410.00

(See definition of Part-Time Student below.)

Room and Board per Quarter* ..... $ 355.00
Tuition, Room and Board are due and payable in full one week before the beginning of each Quarter.

Fee for each change in scheduled course ..... $ 2.00

Fee for challenging a course (per course) ..... $ 10.00

Late Registration Fee ..... $ 20.00

Late Submission of Form Fee (administrative forms, e.g., pre-registration, application for degrees, etc.—per day). ..... $ 2.00

Fee for Replacement of Identification Card ..... $ 5.00

Breakage Deposit for Chemistry Courses with laboratory depending on course ..... $5.00–$20.00
(Unused amount returned to student at close of course.)

Additional copies of student's transcript of grades (each copy of transcript) ..... $ 1.00

Graduation Fee ..... $ 25.00

For Graduate, Law, and Summer Session, tuition and fees –

(See announcement of Graduate Divisions and Summer Session.)

During the Senior Year, all students must take *no less than two courses per term.*

A Full-Time Student who drops courses during the Term will be considered full time for the balance of that Term.

Part-Time Students:

A Part-Time Student is defined as a Lower-Division Student taking less than three (3) Term Courses, or an Upper-Division Student taking less than two (2) Term Courses.

Law Students:

A Law Student in the Day Division taking less than ten (10) Semester Units will be charged on the basis of $65.00 per Semester Unit.

A Law Student in the Evening Division taking less than eight (8) Semester Units will be charged on the basis of $65.00 per Semester Unit.

These rates do not apply to Law Students receiving scholarship aid, all of whom are considered to be full-time students.

All resident students must bring their own towels, blankets, bedspreads, sheets, pillow cases, and desk lamps.

Charges for loss or damage in residence halls or to military equipment will be billed directly to the student and parents upon report of damage or loss.

*Room and Board (Winter and Spring Recess):

By arrangement with the Dean of Students.

METHOD OF PAYMENT

Students should come prepared to pay all charges on the day of registration, or should have payments from home in the mail to reach the University at least TWO WEEKS prior to the date of registration.

Remittances should be made payable to the "University of Santa Clara" and mailed to the Office of the Treasurer.

Students who have unpaid bills at the University or who defer payments without approval are subject to dismissal from the University and, as long as such payments remain unpaid, may not receive transcripts of credits nor any diploma.

For those who are not financially able to pay the full term charges in advance, there are several tuition plans available. Those who plan to avail themselves of one of these services should request information from the University at least one month prior to registration.

In addition, the University has several loan funds which are available to the students and their parents.

REFUND OF TUITION: FULL-TIME STUDENTS

Students who withdraw from the University may receive refunds of tuition according to the following schedule:

For withdrawal prior to the first Monday after registration: payment refunded minus $125.00

For withdrawal prior to the second Monday after registration: payment refunded minus $170.00

For withdrawal prior to the fourth Monday after registration: payment refunded minus $245.00

No further refunds of tuition will be allowed.

REFUND OF TUITION: PART-TIME STUDENTS

Students who withdraw from the University may receive refunds of tuition according to the following schedule, per course:

For withdrawal prior to the first Monday after registration: payment refunded minus ..... $ 70.00

For withdrawal prior to the second Monday after registration: payment refunded minus 85.00

For withdrawal prior to the fourth Monday after registration: payment refunded minus 115.00

No further refunds of tuition will be allowed.

REFUND OF ROOM AND BOARD

Refund of unused board will be prorated from the Monday following the date of withdrawal.

No refund will be made of the payment for a room in the University's residence halls.

Refunds cannot be processed until one month after the student's withdrawal.

The above fees and charges are subject to change without notice.

DEFERRED PAYMENT PLANS

Santa Clara provides a deferred payment plan which is administered through outside agencies. One-, two-, three-, and four-year contracts are available.

LOANS

National Defense Student Loan Fund

Assistance from this fund is available to any student in good standing, including incoming freshmen. Financial need must be demonstrated. Application form and general information concerning this fund may be had from the Office of Financial Aids.

United Student Aid Funds Inc.

These funds are available to sophomores, juniors, seniors, professional and graduate students. Application form and general information may be had from the Office of Financial Aids.

The Catala Club Loan Fund

This fund, established and administered by the Catala Club, is available to sophomores, juniors, and seniors. The officers of the Catala Club may be contacted through the University business office.

American Bar Association Fund

This fund is available to students in the School of Law. Application is made through the Dean of the School of Law.

Bing Crosby Youth Fund Student Loan

This fund is available to sophomores, juniors and seniors. Information concerning this fund may be had from the Office of Financial Aids.

F. W. Conlogue Loan Fund

This fund is available to sophomores, juniors and seniors. Information concerning this fund may be had from the Office of Financial Aids.

JOBS

Employment during the school year is not encouraged, and students will not be permitted employment which intrudes on their required study hours; however, Santa Clara realizes that this is necessary in some cases. The University maintains a Placement Bureau on campus to assist students in securing part-time work.

Students who receive financial aid are expected to work during summer vacation. From their summer earnings men are expected to contribute at least $400, women $300, to meeting their costs at Santa Clara.

SCHOLARSHIPS

UNDERGRADUATE — Entering students

Scholarships vary in amount from $200 to $2400 and are renewable, provided the student fulfills the University's requirements and files for renewal each year. The stipend may be adjusted if the applicant's financial circumstances change substantially.

To qualify for scholarship consideration, a student must:

1. Secure a copy of the Parents' Confidential Statement form (a questionnaire on finances) provided by the College Scholarship Service, have it completed and forwarded to the Service not later than February 15, requesting that a copy be sent to Santa Clara. (No other application for scholarship assistance is required.) Copies of the Parents' Confidential Statement may be obtained from the high school or from College Scholarship Service, Box 1025, Berkeley, California 94701.
2. Arrange to take the Scholarship Aptitude Test of the College Entrance Examination Board, in November, December or January. (California residents must take the test in November or December to qualify for a California State Scholarship); request that the scores of the Scholastic Aptitude Test be sent to Santa Clara.
3. Send the following to the University of Santa Clara by February 15: an application for admission with the $15.00 application fee, a transcript of high school work for at least seven semesters, and three letters of recommendation from specified persons. (Recommendation forms are provided with the application.)

California residents must apply for California State Scholarships if they intend to seek assistance from Santa Clara.

All scholarship applicants will be notified of the disposition of their requests. Notification of scholarship awards will be made no later than May 1.

UNDERGRADUATE — Present Students

California residents must apply for California State Scholarships if they intend to seek assistance from Santa Clara.

Petitions for new scholarships by students already in attendance at the University must be submitted during the month of May to the Director of Financial Aids. The necessary forms for this purpose are available in the Office of Financial Aids.

UNDERGRADUATE — Transfer Students

Students who are presently enrolled in an institution of higher learning who plan to transfer to Santa Clara and who wish to apply for scholarship assistance should write to the Registrar for instructions.

QUALIFICATIONS

Besides the conditions laid down by the donors, all scholarships administered by the University are subject to the following conditions:

1. In selecting students for scholarship benefits, evidence of financial need is required. From the applications which satisfy this requirement, preference will be given to students with higher scholastic attainments.
2. Students who are recipients of scholarships must maintain an average of at least 3.00 (B) and be approved by the Committee on Academic standing.
3. In selecting students for scholarships, participation in extracurricular activities will be taken into account. Continuance in extracurricular activities will be required of all holders of scholarships.
4. A student who holds a scholarship must file a petition for renewal each year. Petitions for new or renewed scholarships by students already in attendance at the University must be submitted during the month of May to the Director of Financial Aids. Forms for this purpose are available in the Office of Financial Aids.
5. Scholarships may be cancelled at any time for infractions of the rules and regulations of the University.

William J. Adams, Sr. Scholarships: Two annual scholarships contributed in 1962 and subsequently by Florence M. Adams of Santa Cruz, in memory of her husband, Mr. William J. Adams, Sr., for the benefit of two needy and deserving students, one each in the School of Engineering and in the School of Law; selection to be made by the Committee on Scholarships.

Alumni Scholarship: A perpetual scholarship provided by "The Alumni Scholarship Fund" ($1,620) established in 1945 by the University of Santa Clara Alumni Association for the benefit of a deserving student.

The Bishop Floyd L. Begin Scholarship: A scholarship provided by a gift in 1964 by Mr. and Mrs. John J. Donovan, Jr. in honor of the Most Rev. Floyd L. Begin, S.T.D., Bishop of Oakland. The scholarship shall be awarded to a needy and deserving student from the Diocese of Oakland nominated by the incumbent Bishop.

Jesse W. Bryan Scholarship: A perpetual scholarship provided by a gift ($12,500) in 1913 from Mrs. Sarah A. Bryan of San Francisco, in memory of her son, Mr. Jesse W. Bryan (S.C. 1891-92), for the benefit of a boarding student.

Edwin J. Brown Fellowship: A perpetual fellowship provided by a gift of some $12,000 from Edwin J. Brown, Emeritus Chairman of the Department of Education. This fellowship carries full-tuition and cash proceeds from the contribution. Must go to a carefully selected male, full-time graduate student in the Teacher Education program. Selection by the Department of Education with the Director of Teacher Education as Chairman.

Magin Catala Scholarship Fund: A perpetual scholarship provided by contributions ($10,000) in 1954 and subsequently by the Catala Club of the University of Santa Clara, for the benefit of a deserving and needy student majoring in Liberal Arts; selection to be made by the President of the University.

James W. Coffroth Scholarships: Perpetual scholarships provided from the Trust Fund ($18,800) established in 1943 at the Wells Fargo Bank, San Francisco, by the bequest of James W. Coffroth of San Diego, for the benefit of needy undergraduate students.

Katherine Connor Scholarship: A perpetual scholarship provided by bequest ($4,500) in 1942 from Miss Katherine Connor of San Jose, for the benefit of students designated by the President of the University.

Robert L. Coward Scholarships: Annual scholarships contributed in 1918 and subsequently by friends of the University, in memory of Mr. Robert L. Coward (S.C. 1896-99), for the benefit of needy and deserving students who are outstanding for contributions to the extracurricular activities of the University.

Crown Zellerbach Foundation Scholarships: Two scholar-

ships. One annual scholarship contributed in 1956 and subsequently by the Crown Zellerbach Foundation, for a deserving undergraduate student; selection to be made by the Committee on Scholarships. One annual scholarship contributed in 1964 and subsequently by the Crown Zellerbach Foundation, for a deserving graduate student; selection to be made by the Dean of the School of Business.

DE SAISSET-FILIPELLO SCHOLARSHIP: A perpetual scholarship provided by a gift ($1,500) in 1944 from Miss Isabel de Saisset and Mrs. E. A. Filipello of San Jose, for the benefit of a student designated by the President of the University.

HUGH C. DONAVON SCHOLARSHIPS: Perpetual scholarships provided by a bequest ($5,000) in 1961 from Miss Josephine E. Donavon of San Francisco, in honor of her brother, Rev. Hugh C. Donavon, S.J., longtime Professor of the University, for the benefit of undergraduate students designated by the President of the University.

JAMES DUNNE SCHOLARSHIPS: Fifteen perpetual scholarships provided by a gift ($224,604) in 1931 from Mrs. Viola K. Dunne of Hillsborough, in memory of her husband, Mr. James Dunne, (S.C. 1863-74), for the benefit of resident students from the State of California.

MAMIE H. EVANS SCHOLARSHIPS: Perpetual scholarships provided by "The Mamie H. Evans Memorial Scholarship Fund" ($9,753) established in 1938 by a bequest from Mrs. Mamie H. Evans of Butte City, for the benefit of needy and deserving students.

FARMERS INSURANCE GROUP SCHOLARSHIPS: Annual scholarships contributed in 1958 and subsequently by The Farmers Insurance Group, for the benefit of deserving students in the School of Law.

WILLIAM C. GIANERA SCHOLARSHIPS: Perpetual scholarships and grants-in-aid provided by the Fund ($14,859) inaugurated in 1951, by friends of the University in honor of William C. Gianera, S.J., former President of the University (1945-51), for the benefit of needy and deserving students.

ROBERT E. GROSS/LOCKHEED AIRCRAFT CORPORATION: Perpetual scholarships or fellowships provided by a gift ($50,000) in 1963 from Lockheed Aircraft Corporation, for the benefit of students majoring in science, engineering, economics, or other fields applicable to the aerospace, marine, manufacturing, or construction industries; selection to be made by the Committee on Scholarships.

ROBERT AND GUILLERMINA GRAHAM SCHOLARSHIPS: Perpetual scholarships provided by a Fund ($22,387) inaugurated in 1950 by Mr. and Mrs. Robert M. Graham, (S.C. 1925-29 and former Bursar of the University), for the benefit of needy and deserving students of the Catholic Faith.

CLAUSIN D. HADLEY SCHOLARSHIP: A perpetual scholarship provided by a gift ($2,500) in 1962 from Martha Hadley of Los Altos in

memory of her husband, Dr. Clausin D. Hadley, for the benefit of a needy and deserving student of the School of Business; selection to be made by the Committee on Scholarships.

Francis William Harvey Scholarships: A perpetual scholarship provided by a bequest ($12,500) in 1966 from Anna C. Harvey in honor of her son, Francis William Harvey, for the benefit of a male student in the School of Business from Santa Clara County, selection to be made by the President of the University.

Robert L. Jacobs Scholarship: A perpetual scholarship provided by a Fund ($1,025) established in 1945 by friends of Mr. and Mrs. Leon Jacobs of San Jose, in honor of their son, Robert L. Jacobs (S.C. 1941-45), who gave his life in World War II, for the benefit of a student designated by the President of the University.

John F. Kennedy Scholarships: A limited number of scholarships (amounts according to need) to be awarded to undergraduate students of promise from minority and low-income backgrounds, in memory of President John F. Kennedy.

Knights of Columbus Scholarship: An annual scholarship contributed in 1948 and subsequently by the California Knights of Columbus, for the benefit of a needy and deserving student.

George P. Lauinger Scholarships: Perpetual scholarships provided by bequest ($5,000) in 1962 from Mr. George P. Lauinger of San Mateo, for the benefit of needy students of high scholastic standing; selection to be made by the Committee on Scholarships.

Thomas and Dorothy Leavey Foundation Scholarship: An annual scholarship contributed in 1958 and subsequently by the Thomas and Dorothy Leavey Foundation, for a deserving student; selection to be made by the Committee on Scholarships.

George H. Mayr Scholarships: Annual scholarships contributed in 1953 and subsequently by the George H. Mayr Educational Foundation of Los Angeles, for the benefit of needy and deserving students from the State of California.

Jennie L. Murphy and Bessie W. Murphy Scholarship Fund: Perpetual scholarships provided through a gift ($5,000) in 1955 from the heirs of the Bessie W. Murphy Estate, in memory of Jennie L. Murphy and Bessie W. Murphy, to be used for worthy students not otherwise able to receive an education; selection to be made by the President of the University.

Helen Louise O'Brien Scholarship: A perpetual scholarship provided by a bequest ($88,000) in 1968 from Helen L. O'Brien of San Mateo in memory of her nephew and niece, John Bruce Winship and Barbara Margaret Winship, for the benefit of needy students.

Edwin J. Owens Scholarship Fund: A perpetual scholarship provided by contributions in 1961 and subsequently by the Catala Club of the University of Santa Clara, in honor of Judge Edwin J. Owens, for the benefit of a needy and deserving student; selection to be made by the President of the University.

John Paul Paganini Scholarship: A perpetual scholarship provided by a gift ($10,000) in 1945 from Mr. Charles M. Paganini and Family of San Francisco, in honor of his son, John Paul Paganini (S.C. 1934-38), who gave his life in World War II, for the benefit of a student designated by the President of the University.

Amelia Parreira Scholarship Fund: Perpetual scholarships provided by a gift ($6,985) in 1962 from Peter J. Pasetta of Saratoga for the benefit of needy students of high scholastic standing.

Peter J. Pasetta Scholarship Fund: Perpetual scholarships provided by a gift ($6,985) in 1962 from Peter J. Pasetta of Saratoga for the benefit of needy and deserving students of the School of Business; selection to be made by the Committee on Scholarships.

Benjamin Patocchi Scholarship: A perpetual scholarship provided by a bequest ($8,000) in 1949 from Mr. Benjamin J. Patocchi of Sonoma County, for the benefit of a student designated by the President of the University.

James D. Phelan Scholarships: Perpetual scholarships provided by a bequest ($50,000) in 1931 from the Hon. James D. Phelan, former mayor of San Francisco and United States Senator, for the benefit of students designated by the President of the University.

Regents' Scholarships: A limited number of scholarships (amounts according to need) contributed in 1968 and subsequently by the Board of Regents and the Board of Fellows of the University for the benefit of disadvantaged students.

John McKenna Scott Scholarship Fund: A perpetual scholarship provided by a bequest ($9,737) in 1957 from Mr. John McKenna Scott of San Francisco, for the benefit of a Mechanical Engineering student selected by the Board of Trustees according to norms indicated by the donor.

Catherine Sexton Scholarship: A perpetual scholarship provided by a bequest ($18,000) in 1946 from Mr. John E. Sexton, Jr., of Palisade, Nevada, in memory of his mother, Mrs. Catherine Sexton, for the benefit of a boarding student from El Dorado County, California.

John Sexton Scholarship: A perpetual scholarship provided by a bequest ($18,000) in 1946 from Mr. John E. Sexton, Jr., of Palisade, Nevada, in memory of his father, Mr. John E. Sexton, Sr., for the benefit of a boarding student from El Dorado County, California.

J. E. Sexton Scholarship: Perpetual scholarship provided by a bequest ($18,000) in 1946 from Mr. John E. Sexton, Jr., of Palisade, Nevada, for the benefit of a boarding student from Eureka County, Nevada.

Earl C. Smart Scholarships: Perpetual scholarships provided by a bequest ($7,500) in 1957 from Mr. Earl C. Smart of San Jose, for the benefit of students designated by the President of the University in accord with the wishes of the donor.

Alice Phelan Sullivan Scholarships: Perpetual scholarships provided by a gift ($6,500) in 1912 and a bequest ($10,000) in 1957 by Noel Sullivan, in memory of his mother, Mrs. Alice Phelan Sullivan of San Francisco, for the benefit of students designated by the President of the University.

The Walter V. Walsh Scholarship Fund: Perpetual scholarships provided by a bequest ($5,000) in 1957 from Mr. Walter V. Walsh of San Francisco, for the benefit of needy and deserving students in the School of Law.

Frank and Alice Walterstein Scholarships: Perpetual scholarships provided by a bequest ($35,916) in 1949 from Mrs. Alice Walterstein, for the benefit of students designated by the President of the University.

Western Electronic Manufacturers Association Scholarship: An annual scholarship contributed in 1953 and subsequently by the Western Electronic Manufacturers Association, for the benefit of needy and deserving students majoring in Electrical Engineering or in related scientific fields; selected by the Committee on Scholarships.

George E. Lenzen Memorial Scholarship: A perpetual scholarship provided by a bequest ($2,010) in 1968 from George E. Lenzen of San Jose for the benefit of deserving students.

The Aaron Richards Memorial Scholarship: A perpetual scholarship provided by a gift ($30,000) in 1967 from Mrs. Reva K. Richards of San Jose, in memory of her husband, Mr. Aaron Richards (S.C. 1926-29), for the benefit of needy and deserving students.

John P. Borrelli Scholarship Fund: Perpetual Scholarships provided by Mrs. John P. Borrelli and others (totaling $10,000) in memory of her son for needy and deserving students with preference in Mathematics.

JESUIT SCHOLARSHIPS

SANTA CLARA: A limited number of annual scholarships (amounts according to need) contributed in 1930 and subsequently by the Jesuit Fathers of the University, for the benefit of needy and deserving students selected by the Committee on Scholarships.

FR. HARRY STREHL, S.J.: Annual full-tuition scholarships contributed by the Jesuit Fathers of the University, for a graduate of each of the fourteen Jesuit high schools in the west, selected by the principal of each institution from the five seniors with the highest academic rank; renewable for an additional three years by meeting University scholarship requirements.

EMERY: A limited number of scholarships (amounts according to need) in the School of Law, contributed in 1956 and subsequently by the Jesuit Fathers of the University, in honor of James A. Emery (S.C. 1893-96), for the benefit of needy and deserving students selected by the Committee on Scholarships.

Membership in groups and participation in extracurricular life are encouraged as such activity can be a valuable adjunct to the education of the Santa Clara man or woman. Although freshmen should limit their activities somewhat, they will readily find clubs whose purposes will correspond to their interests.

The Associated Students plan and administer an extensive social program which ranges from class- and group-sponsored picnics to more formal dances in prominent hotels, often in San Francisco. The University's proximity to San Francisco also allows it to bring the more famous personalities in the intellectual, cultural, and entertainment world to its campus.

Each student will find that the personal touch is very much a part of the Santa Clara tradition. Freshman Week is planned with the idea of helping new students to become familiar with the various phases of campus life. A large representation of upperclassmen will be on hand to meet with new students and to assist with the problems particular to incoming students. Special counseling and orientation plans for upperclass transfer students take place prior to registration. The Fall Homecoming Weekend, scheduled for early November, is not only a highlight of the social calendar but also serves as an excellent way for students to become acquainted with each other and with the alumni.

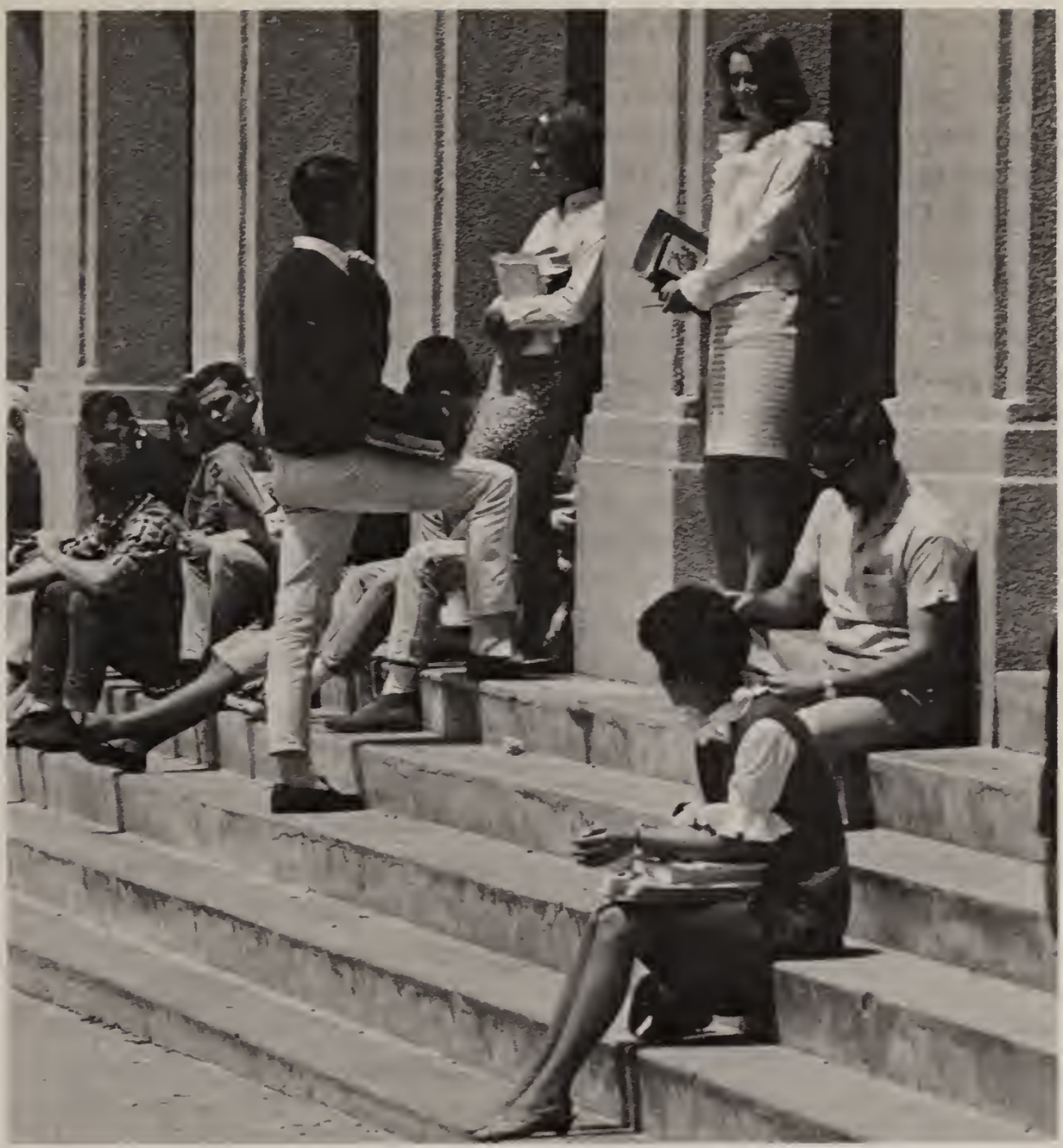
The personal approach does not end with Freshman Week, nor is it restricted to student relationships. Faculty seminars in dormitory lounges and informal get-togethers provide a relaxing medium for discussion and enjoyment.

The University feels that an active cultural and social program is an essential part of the educative process. Accordingly, the Student Council and various organizations, under the supervision of the Dean of Students, execute an extensive and varied activities program.

The major intercollegiate sports are football, baseball, and basketball; other sports are tennis, water polo, golf, soccer, swimming, and rugby. A full complement of intramural sports allows any student to participate.

The University maintains a program of recreational activities for women, under a Director of Women's Recreation. Golf, tennis, swimming, water-safety and life saving, bowling, and many other active sports are included. Participation is open to all students according to interests and time limitations.

Although Santa Clara has grown rapidly in the last few years, it retains a friendly atmosphere and a personal relationship environment for which it is famous. This is a vital part of student life and an essential part of the University's particular kind of education.



Students participating in public debates, oratorical or dramatic arts contests, or representing the University in intercollegiate athletic events, or appointed to the staff of any University publication, or elected or appointed to office in the student government, a student organization or society, are subject at the time of their selection or appointment, to the following eligibility rules:

1. They must have no failures.
2. They must have attained a "C" average in their mid-term or term examinations.
3. They must not be on probation for academic or disciplinary reasons.

In addition, candidates for the office of student body president must have a "C+" (2.5) average.

STUDENT CONDUCT

The problem of conduct is a serious charge on the institution which both respects human rights and accepts the responsibility for guiding students to maturity. Many students are away from home for the first time in their lives; others are finding new horizons opening to them as their educational experiences broaden.

Since the University of Santa Clara believes in the dignity and importance of each person entrusted to its care, it accepts the responsibility of directing varied abilities and goals, guiding different personalities and interests, and understanding, and sometimes sharing, myriad student problems. The rules and regulations of the University are a means to an end and aid in the development of the student; they are not designed solely to restrict him.

Campus discipline is conducted under Student Government and is handled through the office of the Dean of Students. Every effort is made to guarantee and protect student freedoms. However, the University reserves the right to dismiss any student whose conduct is seriously inconsistent with the goals of the University and the public good. The Board of Student Appeals processes cases. Through constant evaluation, new interpretations are developed in the light of democratic principles. The freedom to speak, to organize, to participate are rights guaranteed to all students, providing an environment of intellectual freedom.

STUDENT GOVERNMENT

The system of student government at Santa Clara makes the students themselves responsible for the conduct of student affairs.

Students organize and supervise academic, cultural, and social activities through class governments, clubs, and committees. In the Student Senate, the students establish the rules and regulations and sanctions governing student activity in the residence halls, at athletic and social events, and at extracurricular events on campus. In the Board of Student Appeals representatives of the students, faculty, and administration hear cases involving major violations of regulations and determine what sanctions are to be applied.

Law students have their own Student Bar Association as the instrument of student government in the Law School. Therefore, law students are not represented in the Student Senate and are not subject to the jurisdiction of the Student Senate and the Student Court.

Student government at Santa Clara plays a vital role in the education of the students. As a genuine government of the students by the students, it develops responsibility and integrity in individual students.

STUDENT HOUSING

The University maintains 12 dormitories, six for women and six for men. They provide as homelike an atmosphere as possible within the framework of the University's educational requirements. Three swimming pools are available. Upper-classmen are encouraged to select their roommates, that as much as possible personal preferences may be served. This privilege is not accorded freshmen.

Acceptance to the University as an undergraduate automatically includes acceptance in a residence hall. Freshman and sophomore undergraduate students who do not live with parents or other adult members of their families must live on campus. Housing deposit should be submitted as soon as acceptance notification has been received.

Room assignments are made by the Director of Housing. No single rooms are available. Freshmen will receive room assignments by mail in August. Sophomores, juniors, and seniors may request a specific hall and/or roommate, if they wish. These applications must be in writing and be received before July 15. Anyone who wishes a nonsmoker for a roommate should make this request to the Director of Housing before July 15.

Rooms are provided with beds, pillows, mattresses, towel racks, bookcases, chairs, desks, chests of drawers, medicine chests. (A charge will be made for damage to rooms or furniture.)

Students must provide blankets, sheets, towels, pillowcases, washcloths, bedspreads, desk lamps.

Helpful extras could include a typewriter, an alarm clock, ash trays, a mending kit, and closet accessories.

Special service rooms are conveniently located in each building, with proper outlets for electric irons, hot plates, heaters, sun lamps, hair dryers, and such appliances, which are not permitted in the rooms. There is a linen rental, laundry and dry-cleaning service available on campus for the convenience of students. Television sets for student use are in various locations on campus. Room assignments are not made until the housing deposit is received.

STORAGE OF PERSONAL PROPERTY

The University of Santa Clara is not responsible for personal property located on campus.

With the exception of losses from fire, any loss from dishonesty, destruction or disappearance is strictly a personal matter. It is the individual's responsibility to secure his or her own insurance coverage.

STUDENT HEALTH SERVICE

The Student Health Service is located in the Donohoe Infirmary on the University Campus and is under the supervision of the Director of Medical Services for the University of Santa Clara.

All full-time undergraduate students and full-time law students are eligible for medical care under the following conditions:

1. The Student Health Service has a physician in attendance from 8 a.m. to Noon, Monday through Friday, while classes are in session. Visits to the Student Health Service during these hours should be made by calling the Infirmary for an appointment. At all other times while the University is in session, medical care is available in cases of bona fide emergencies. The Student Health Service may be contacted through the Infirmary or the University switchboard operator. With the exception of drugs, laboratory work and X-ray, no fee is charged to students utilizing the service.

2. Drug prescriptions may be filled at the University-designated pharmacy; the student will be billed for such prescriptions by the University. Prescriptions may, of course, be filled at any pharmacy but in that case, it is the student's responsibility to make financial arrangements with the druggist of his choice for payment of the prescription.

3. X-rays, laboratory work, general hospital charges, consultations by physicians other than the University physicians and medical care rendered at a general hospital (with the exception of emergency room visits by one of the University physicians) will be charged to the student.

4. In-patient care is available to undergraduate resident students only, at no charge.

5. All students, of course, have the right to obtain medical care outside of the services offered by the Student Health Service, but in that case, the financial obligation for such care is the responsibility of the student.

All students are required to have a pre-entrance health examination by their personal physician. The results of such an examination are to be reported to the Student Health Service on the form designated by the University on or before the date of registration.

COUNSELING SERVICES

A variety of counseling services are conveniently available to all students. The University Chaplain and his assistant provide religious guidance in personal interviews and during the University retreats. The deans of the Colleges and Schools and the professors of the student's major department usually take care of the academic counseling of the students.

The University Counseling Center is complementary to, and supportive of, the total university counseling, guidance, and advisement effort. A professional staff of psychologists and guidance specialists is available to aid the students in dealing with academic, occupational planning, and personal-social problems which may confront them as maturing men and women. Counseling and testing procedures are used that are appropriate to the student's needs. The fundamental objective of these services is to enable the student to use his own resources in dealing with the problems he confronts.

STUDENT PUBLICATIONS

The Santa Clara is the official weekly newspaper of the University. It publishes news of the University and affords students an opportunity for practice in newspaper editing, managing, and make-up.

The Redwood is the University annual published by the students to serve as a record of University activities and of the students' achievements.

The Owl is a quarterly literary magazine. It offers a medium of literary expression for the students.

The Santa Clara Lawyer is published twice yearly by the School of Law.

The Alma Studies — A Theological Review is a semiannual publication of the students of the School of Theology. Its primary purpose is to stimulate theological research and effective writing.

PLACEMENT BUREAU

The Placement Bureau, in the Benson Memorial Center, serves as a clearinghouse of information for seniors and maintains schedules of visits by business and governmental employment representatives. The schedules are distributed to all seniors, and a wide range of literature on career and job opportunities is available in the Placement Bureau for graduating students.

The Placement Bureau also assists students who wish to apply for part-time work during the school year and for vacation jobs. Students who desire such work during the school year should file their applications and qualifications at registration time.

ASSOCIATED STUDENTS

The Associated Students of the University of Santa Clara (ASUSC) is the student body organized for the conduct of student government. All fee-paying registered students are members.

The purposes of the ASUSC are to further the best interests of the University and its students, to encourage student activities, and to provide valuable experience and training in self-government and responsibility.

RELIGIOUS ORGANIZATIONS

The first thought of the University is the encouragement of a sound religious life for the men and women of the student body. Spiritual activities include The Confraternity of Christian Doctrine, The Sodality of the Blessed Virgin, The Lambdas (Liturgical Group), The Chaplain's Retreat Organization, and the Sanctuary Society.

Alpha Sigma Nu is a national honor society with chapters in various Jesuit colleges and universities throughout the United States. It is a society of honor students who have distinguished themselves in scholarship, service and loyalty to their college or university.

American Chemical Society Student Affiliates is an organization of students affiliated with the parent national group of chemists, the American Chemical Society. Affiliates are entitled to junior level participation in the sectional society meetings.

American Society of Civil Engineers has as its purpose to promote student interest in the function and profession of civil engineering by means of meetings, field trips, and lectures. Membership is open to any student interested in civil engineering; there is a $2.00 annual membership fee.

American Society of Mechanical Engineers works to provide students with current information on the profession of mechanical engineering. Activities of the society, which is open to all students, include lectures, field trips, and various social events.

Beta Gamma Sigma, Delta Chapter, is a professional business honor fraternity to encourage and reward scholarship and accomplishment among students of commerce and business. It promotes the advancement of education in the art and science of business and fosters integrity in the conduct of business operations. Members are selected on the basis of high scholarship and good moral character.

Delta Sigma Pi, Gamma Xi Chapter of the Delta Sigma Pi National Commerce Fraternity, is a professional fraternity of students who are above average academically and who are leaders in the activities of the School of Business.

Finance Club:The University of Santa Clara Finance Club is a chapter affiliate of the American Finance Association, a national professional society of some 4,000 members representing university teachers and professional people from business, government and finance. The primary objective of the organization is to promote individual interest and knowledge in the various areas of finance through the interchange of ideas and research by people in finance. Membership in the student chapter provides the opportunity to participate in meetings, forums and seminars involving leaders of the business and financial communities.

Gamma Pi Epsilon is a national honor society for women students in Jesuit colleges and universities throughout the United States. Selected from the upper twenty-five per cent of the junior or senior class, members are chosen for their distinction in scholarship, service, and loyalty to their college or university. Membership in this society in considered the highest honor bestowed on undergraduate women students at Santa Clara.

Institute of Electronic and Electrical Engineers (IEEE) aims to give electrical and electronic engineers a more complete education by acquainting them with the electronics industry. Activities of the institute include field trips to local electronics firms, guest lectures, and a thesis competition for all senior engineers. All students of the School of Engineering are eligible to join.

The Marketing Club is the University student chapter of the American Marketing Association. It welcomes all students who have an interest in marketing. The Club sponsors a lecture series and other activities of current interest. Members also are eligible to participate in the student activities of the American Marketing Association.

Pershing Rifles, a national society, has as its purpose to encourage, develop, and preserve the highest ideals of the military profession, to provide appropriate recognition of a high degree of military ability among cadets of the Reserve Officers' Training Corps, and to instill in the membership the need for assuming civic responsibility. Active membership is open only to cadets of the Basic Course.

Phi Alpha Theta is an international History honor society composed of students and professors selected upon the basis of excellence in the study and writing of History. The objectives of the fraternity are to bring students, teachers, and writers of History together both intellectually and socially, and thereby encourage the exchange of learning and thought among historians.

Pi Mu Epsilon is the national honor fraternity in mathematics on the University campus. The fraternity sponsors lectures, both for members and for the general public, and a number of closed social affairs. Membership is by invitation to juniors and seniors with a minimal 3.5 grade point average.

Scabbard and Blade is a national society composed of selected members of the Advanced ROTC. Its purposes are to unite in closer relationship the military departments of American universities and colleges, to develop the essential qualities of good and efficient officers, to prepare members to exert good influence in the military affairs of the communities in which they reside, and to spread intelligent information concerning the military requirements of our country.

Society for the Advancement of Management aims to improve student understanding of the business community. The society operates in conjunction with the School of Business, and membership is open to all students of that school.

Tau Beta Pi is a national engineering honor society. The California Zeta Chapter was installed to give increased recognition to outstanding scholastic achievement. Its members are selected on the basis of scholarship, integrity and diligence.

DEPARTMENTAL ORGANIZATIONS

Blackstone Pre-Legal Society is composed of undergraduate students who aspire to attend law school and wish to acquaint themselves with the general duties of the legal profession before beginning their graduate work.

Bridge Club works to promote interest in bridge and to provide playing facilities both on and off compus. The club organizes on-campus bridge tournaments, instruction in bridge playing, and off-campus competition. The club is open to all students; there is a nominal fee for membership.

The Business Administration Association is an organization of students in the School of Business for the study of business problems and for the encouragement of social activities among the students of the School. Frequent lectures are given before the Association by businessmen of prominence.

Charlie Graham Club is a service organization dedicated to assisting the Department of Athletics and the ASUSC. The club aids in the maintenance of Buck Shaw Stadium and provides service at sports events, parties, and other activities. Membership is limited to 75 men students elected from the junior and senior classes.

Chess Club aims to provide on-campus facilities for chess instruction and matches and to arrange for competition with other chess clubs. Membership is open to all students.

The Clay M. Greene Players is an organization having exclusive charge of the formal dramatic presentations on the campus. Distinguished plays of the past were "The Passion Play of Santa Clara," by Clay M. Greene, and "The Mission Play of Santa Clara," by Martin V. Merle. Modern theatrical productions are presented regularly.

The Debating Societies engaged in intramural and intercollegiate debates. Highlighting the year's activities are the annual Foch and Ryland debates, as well as intercollegiate tournaments. The traditional debating society on the campus is the Literary Congress which held its first meeting February 22, 1857.

The Engineering Society is an organization of students in the School of Engineering with the object of familiarizing them with the conduct of public meetings for the acquisition of ease in public speaking. Lectures to the engineering students are given before this body by guest speakers.

Flying Club attempts to provide students with the opportunities for flying experience necessary for a pilot's license. The club sponsors film presentations and offers flying services for campus organizations at discount rates. All students are eligible; previous experience in flying is not necessary.

German Club seeks to provide students with an opportunity to become better acquainted with the culture and language of Germany. The club's activities include film presentations, informal discussions in German, and programs at the Goethe Center in San Francisco. The club is open to all students acquainted with the German language.

International Students' Club aims to improve understanding of foreign cultures by bringing together students of different countries. Activities include meetings, lectures, films and an International Dinner for the entire student body. All students are eligible for membership and foreign students are especially invited to join.

Irish Club aims to spread the Irish spirit and to promote Hibernian culture in the University community. One of the principal activities of the club is the celebration of Saint Patrick's Day. Membership is open to all Irishmen.

Kappa Zeta Phi is a campus organization devoted to the service of the University. It is an honor fraternity composed of students who are above average academically and who are outstanding in campus activities and in loyalty to the University and the student body .

The Mathematics Society is open to all interested students. Its primary purpose is to stimulate interest in mathematics and its applications.

Mendel Society is an association of students preparing for the study of medicine, organized to investigate scientific subjects and to encourage such activities as are of particular interest to students of biology.

The Phoenix is open to all students of the University interested in the Creative Arts. The organization presents exhibits, lectures, gallery tours, light shows, ballet recitals and the Cinema Classics film series.

Physics Society attempts to encourage the study of physics and to provide an extracurricular source of information on the science. The society, which sponsors guest lectures and educational films, is open to all students.

The ROTC Band performs for Military drill and ceremonies both on and off the campus.

The Rowing Association aims to provide students with an opportunity to learn the skills of rowing and to compete in intercollegiate crew competition on the West Coast. There are four subdivisions within the Association: heavyweight rowers, lightweight rowers, coxswains and a rigging team for shell maintenance. Membership is open to all men students.

Rugby Club aims to provide interested students an opportunity to participate in the sport of rugby and to represent the University in competition with the other colleges and clubs of the Northern Cali-

fornia Rugby-Football Union. All men students are eligible for membership; no previous experience in rugby is necessary.

Santa Clara Christian Action Program (SCCAP) is a community service organization designed to familiarize the Santa Clara student with the problems of the "real" world and to help alleviate those problems through its different community programs. SCCAP's efforts on behalf of the community are directed through fifteen different projects, each with its own coordinator. Membership in SCCAP is open to all students of the University.

Ski Club functions to promote interest and instruct students in the sports of snow and water skiing. The club arranges guest lectures, films, parties, weekend ski trips, and longer ski trips over winter and spring breaks. All students of the University are eligible to become members; dues are $2.50 per year.

Soccer Club aims to promote the game of soccer by either direct or indirect student participation. The club plays a regular season in the California Intercollegiate Soccer Foundation, conducts a spring soccer program, and presents various social functions. Membership is open to all men students who have National Collegiate Athletic Association eligibility.

Sports Car Club works to promote interest in motorcars and to coordinate automotive activities on campus. The club, which plans to affiliate with the Four-Cylinder Club of America holds sports car rallies, tours and other social events. All students, with or without cars, are eligible to join; membership fees are $2.00 per year.

The Student Archeological Committee is a group of students who assist in the discovery and removal of artifacts, bones and other remains from ancient Indian burial sites. They help to classify items discovered and to display these in the campus and regional museums.

Society of United Day Students (SUDS) promotes active participation of the nonresident students in all the campus activities. It has its own elected officers who work closely with the general student body officers.

St. Thomas More Society is open to all students of the School of Law. Its members sponsor communion breakfasts and lectures by prominent Catholic lawyers and religious leaders during the academic year.

Surf Club objectives are to promote campus interest in surfing and other beach activities. The club offers surfing instruction and competition, films, beach trips, and parties. Membership is open to all members of the University community, both students and faculty. Dues are $2.00 yearly.

The University Choir and Glee Club furnish vocal music for services in the Mission Church and the public functions of the University.

ATHLETICS

Athletics at Santa Clara are directed by the Advisory Athletic Council and the Director of Athletics, by whom arrangements for intercollegiate and intramural contests are made. The University is a member of the National Collegiate Athletic Association and the West Coast Athletic Conference.

Block S.C. Society. Members of the University teams who have secured the University letter are organized into the Block S.C. Society in recognition of their athletic ability and for the encouragement of a high standard of athletic conduct.

The Athletic Managers Association is composed of volunteers from each class who cooperate with the management in the conduct of games and the care of equipment.

Intramural Sports. Facilities for the athletic activities of the student body are provided by the gymnasium with its basketball court, weight room, and swimming pool; by centrally located tennis courts; and by the extensive athletic fields for football, baseball, track, softball, rugby and soccer. A program of intramural athletics in which all students are encouraged to participate is conducted under the direction of the Director of Intramural Sports.

ATHLETIC OFFICERS

Charles F. Guenther, S.J., M.A. ..... *Chairman, Advisory Council*
Roger D. McAuliffe, S.J., A.M. ..... *Faculty Advisor*
Jerald G. McGrath, B.A. ..... *Faculty Representative*
George P. Malley, B.S. ..... *Director of Athletics and Football*
Carroll Williams, M.S. ..... *Assistant Director of Athletics*
Salvador F. Taormina ..... *Baseball*
Richard A. Garibaldi, B.S. ..... *Basketball*

STAFF MEMBERS

William McPherson, B.S.	Raymond Anderson, B.A.	Henry Schmidt, B.S.
John Pasco, LL.B.	William Augenstein, B.S.	Richard W. Degnon, B.S.
Al Cadena, B.A.	Dennis Fosdick, B.S.	S. M. Sanfilippo, B.A.
Antonio Ventura, B.A.	Charles Allred, B.A.	Kathryn B. Ivers

GENERAL ACHIEVEMENT AWARDS

NOBILI MEDAL: An annual prize of a gold medal founded by Joseph A. Donohoe, in honor of the first President of Santa Clara, the Rev. John Nobili, S.J., to be awarded to the male student who shall be judged outstanding in personal conduct, activities, and academic excellence.

SAINT CLARE MEDAL: An annual prize of a gold medal, established by the University of Santa Clara, to be awarded to the woman student judged outstanding in personal conduct, activities and academic excellence.

COLLEGE PRIZES

BUSINESS ADMINISTRATION PRIZE: An engraved key given by the Business Administration Association to the senior in the School of Business who shall have made the greatest contribution to the School of Business.

DELTA SIGMA PI KEY: An engraved key given by the Delta Sigma Pi to the senior in the School of Business with the highest scholastic average.

THE ISABEL JONES PRIZE: An annual prize of $100 donated in memory of Mrs. Isabel Jones by her husband, Dr. Eliot Jones, to be given to the senior student of the School of Business who is judged by the Faculty of that School to be outstanding in scholarship.

THE CHARLES J. DIRKSEN PRIZE: An annual prize of $100 donated by Dr. Eliot Jones in honor of Dean Charles J. Dirksen to be given to the junior student in the School of Business who is judged by the Faculty of that School to be outstanding in scholarship.

THE ORELLA PRIZE: An annual award of $75 established in 1915 by the late Dr. Firmin R. Orella, B.S. '89, and founded in 1945 by his wife, Albertine S. Orella, to be given to the senior student in the departments of science who attains the highest average in scientific subjects during the junior and senior years.

THE SCHWARTZ PRIZES: Two annual prizes of $100 each, donated in 1955 by Dr. Sidney L. Schwartz of San Francisco, to be given to students submitting papers in Finance and Business or Economics which shall be judged outstanding by the Faculty of the School of Business.

DEPARTMENTAL PRIZES

THE RELIGION PRIZE: A purse of $100 given by the President of the University (1950), to be awarded annually to an upper-division student, for proficiency in theology, selected on conditions set down by the Department of Theology.

SANTA BARBARA MEDALS: Four gold medals, given by the President of the University, to be awarded annually, on the recommendation of the Professor in Military Science, to the outstanding cadet in each of the four years of training.

THE SOURISSEAU PRIZE: An annual prize of $100 founded in 1955 by Miss Eva Sourisseau of San Jose, in honor of her parents and family, to be given to the senior student of the University who shall be selected by the Department of Philosophy for outstanding philosophical achievement.

THE MICHAEL SHALLO PRIZE IN POLITICAL SCIENCE: An annual prize of $100 founded in 1955 by the University, in honor of Father Michael Shallo, S.J., Professor of Political Philosophy, to be given to the student of the University selected by competition as the most proficient in political science.

THE CIVIC CLUB ITALIAN PRIZES: Three prizes totaling $100 contributed in 1949 and thereafter by the Civic Club of San Jose, to encourage the study of Italian language and culture, to be given to the students attaining the three successively highest grades in the study of Italian.

THE MEDAL OF THE ASSOCIATION OF THE ARMY OF THE UNITED STATES: Awarded to the outstanding cadet of the first year of the

Advanced Curriculum of ROTC, for exceptionally meritorious academic attainments, exemplary conduct, efficiency, and fidelity.

Department of the Army Superior Cadet Ribbon Award: Four ribbons awarded annually by the Department of the Army to the outstanding cadet in each academic class of Senior Division ROTC program at the University who has consistently demonstrated potential qualities as an officer.

The Ryland Prizes: The Hon. Caius T. Ryland founded in 1897 an annual purse of $125, leaving its disposition to the discretion of the Faculty. This the Faculty, after due consideration, assigned to the University Literary Congress, organized February 22, 1857, establishing the Ryland Debate to be held yearly between the two branches, the Senate and the House, and divided the purse into three prizes of $70, $35, and $20, respectively.

The William H. Leahy Prize: A gold watch, valued at $100. This prize was founded in honor of Mr. William Leahy by his wife and his brother, Mr. James Leahy, for the winner of the Dramatic Art Contest.

The Handlery Prize: An annual prize of $100 founded by Mrs. Rose Handlery, in memory of her son, Raymond, of the class of 1934, to be given to the senior student of the University who will have contributed most to the success of any of the University student publications.

The McCann Prize: Annual prize of $60 founded in honor of Daniel B. McCann, B.S., '84, to be given for the best short story.

The Redwood Prize: Annual prize of $25 founded in 1908 by the executive committee of *The Redwood*, and given for the best essay on an historical subject.

The Shipsey Poetry Prize: An annual prize of $50 founded in 1954 by Richard M. Schmidt, in honor of the late Reverend Edward Shipsey, S.J., to be presented to the student selected by the Faculty of the Department of English for the most outstanding contribution in the art of poetry.

The Owl Prize: An annual prize of $60 founded by the directors of the College magazine, *The Owl*, to be given to the winner of an oratorical contest in the University. Since the oratorical contest is no longer held, the prize formerly awarded for the competition is now added to Ryland Debate prizes and divided as follows: $100, $50, and $35, respectively. The prizes will be henceforward called the Ryland-Owl Prizes.

Freshman Mathematics Prize: An annual award of books to a freshman student selected by the Mathematics Faculty for excellence in mathematical study and achievement during his freshman year.

MILITARY SCIENCE

FRANCIS X. LEARY, *Colonel, Professor of Military Science*

The University maintains a Senior Division unit of the Reserve Officers' Training Corps. The course offered consists of a two-year basic and a two-year advanced curriculum.

Through this voluntary program, the University offers each eligible young man the opportunity to obtain an officer's commission while earning his college degree.

The program of instruction is designed to develop qualities of leadership in college-trained men in order to provide a corps of well-educated officers for today's highly technical Army. By combining regular academic pursuits with a course of military instruction, the ROTC graduate is well equipped to assume roles of leadership and command responsibility as an officer in the U.S. Army. Uniforms and textbooks are furnished by the Government without cost to the student.

For those who are interested in Army Aviation, this department offers an Army ROTC Flight Training Program at no cost to the student. Qualified ROTC Cadets pursue this voluntary course during their senior year, and, upon completion, may be awarded a FAA private pilot's license.

ADMISSION INTO THE ADVANCED COURSE, ROTC

Admission to the Advanced Course, Military Science is limited to those students who will not have reached their 28th birthday by the date of their commissioning (graduation). In addition, the following requirements must be satisfied before a student is enrolled in the Advanced Course and administered the oath of enlistment in the United States Army Reserve:

1. Credit for the Basic Course, Military Science with above average grades.
2. Possession of a sufficiently high university grade-point average to insure his continued enrollment during the upper-division Military Science program.
3. Passing the basic mental screening examination.
4. Passing the standard Army physical examination.
5. Favorable recommendation by a joint Academic-Military Board of Review.
6. Concurrence of his respective school Dean.
7. Concurrence of the University President and the Professor of Military Science.

8. Students under the age of 21 at the time of their enrollment in the Advanced Course must have written parental or guardian consent to enter the Course.

Advanced Course students are under contract with the Government to complete their training, unless sooner discharged for the convenience of the Government, and will be paid a monthly subsistence of $50.

ROTC SUMMER CAMP

Advanced Course students are required to attend ROTC Camp, held in the summer and normally between the junior and senior years. This training supplements campus instruction with practical work under field conditions. Included are tactical and technical field exercises and training in the various arms and services. Emphasis is placed on the development of leadership and individual ability to function effectively as an officer-leader of a small unit. While at summer camp, the Advanced Course student will be paid at half the prescribed rate for a Second Lieutenant with less than two years' active service and, in addition, will be authorized a travel allowance of 6 cents per mile to and from camp.

FINANCIAL ASSISTANCE PROGRAM

Four-Year Scholarships

The United States Army offers a four-year Financial Assistance Program for full time college students enrolled in the ROTC Program. To qualify for this program, high school seniors should make application to the Department of the Army no later than January 15 during their senior year. High school guidance counselors and U.S. Army Recruiting Stations should be able to furnish application forms and detailed information on the Assistance Program.

Under the terms of the Financial Assistance Program, the U.S. Army pays all tuition, fees and laboratory expenses. A $100 allowance per school year is granted for the purchase of authorized texts and school supplies. The Army pays the scholarship student a $50 subsistence allowance each month, including the summer vacation months, while the student remains in the program.

Applicants for the program must meet the following eligibility requirements.

1. Be a male citizen of the United States.

2. Have reached the age of 17 and not exceeded the age of 21 as of registration.

3. Be a high school graduate.

4. Be medically qualified.

5. Have parental or guardian consent to enter into contractual agreement with the Government.

6. Have no moral obligations or personal convictions that will prevent him from conscientiously bearing arms to support and defend the Constitution of the United States.

In return for the benefits given under the terms of the Financial Assistance Program, the student, with written parental or guardian consent, enters into contract with the Government to fulfill the following obligations:

1. Complete all Military Science instruction, drills, and summer camp.

2. Enlist in the United States Army Reserve for six years.

3. Accept a commission as a regular or reserve officer and serve on active duty for at least four years.

Two-Year Scholarships

The Department of the Army also offers a two-year Financial Assistance Program for specially selected college juniors who have successfully completed the Basic Military Science Course. Eligibility requirements and incurred obligations under the two-year Financial Assistance Program are the same as those stated for the four-year program, with the following change in eligibility requirements:

1. The student must have reached age 19 and not exceeded age 23 by the time of registration, junior year.

TWO-YEAR ROTC PROGRAM

The Department of the Army offers students who enter the university with advanced academic standing the opportunity to receive a commission after two years of on-campus ROTC training. A student can take advantage of this opportunity by attending a basic summer camp after his sophomore year and then completing the Advanced Course, ROTC, in his junior and senior years. The basic summer camp prior to enrollment in the Advanced Course substitutes for the first two years of the normal four-year program. Except for this substitution, the two programs are identical.

A student accepted into this program obligates himself to accept a commission, if offered, and to serve on active duty in the Army for a period of four years, followed by two years in a Reserve Component.

Prerequisites for enrollment are as follows:

1. Be physically fit and mentally qualified.
2. Be of sound character.
3. Be at least 17 years old. A student must not be more than 28 years old when commissioned.
4. Be recommended by a board of officers.
5. Have successfully completed the basic summer camp training in lieu of the Basic Military Science Course.

ROTC DEFERMENT

Each student who signs the ROTC Deferment Agreement receives a draft classification of 1-D which defers him from call to active duty while he is a student in good standing at the University and until he receives both his baccalaureate degree and his reserve commission as a Second Lieutenant. This deferment is cancelled immediately upon discharge from the ROTC program.

COMMISSIONING IN THE UNITED STATES ARMY RESERVE AND REGULAR ARMY

Students who complete the Advanced Course are eligible for appointment and commission by the President of the United States as officers in the United States Army Reserve. Reserve commissions are tendered in all branches of the Army, except the Medical, Dental, Veterinary, and Chaplain Corps. The branch in which a student is commissioned is determined by his preference, leadership potential, academic background, recommendations of the faculty and staff, and needs of the service. A newly commissioned officer will normally attend his branch school upon being ordered to active duty. Current laws and regulations require each Advanced Course student, upon receipt of his commission, to complete a two-year tour of active duty and to serve in a reserve component for a subsequent period of four years. Delays in reporting to active duty may be granted to students if they desire to obtain an advanced degree. A student may be delayed from call to active duty for a period not to exceed four years, provided he is enrolled in a full-time program of instruction leading toward an advanced degree and remains in good academic standing with the institution in which enrolled.

A student who receives his baccalaureate degree and has been designated a "Distinguished Military Graduate" by the President of the University and the Professor of Military Science may, upon application, be commissioned directly in the Regular Army.

Lower-division students enrolled in the Basic Military Science course will receive term course credit during the one term of the freshman year (MS I) in which they attend classes four days a week, plus a drill period (term course). During the remaining two terms of the freshman year, students will attend two class periods, plus one drill per week (sustaining course). A student, when enrolled in the sustaining course, must complete the course satisfactorily in order to satisfy the baccalaureate requirement of one year of Military Science. Students who elect to continue the Military Science program during the sophomore year (MS II) will attend one class period, plus drill per week (sustaining course), during the fall and winter terms; and two class periods plus one drill per week during the spring term.

During the junior year (MS III), a student attends two class meetings, plus drill per week for three terms (sustaining course). In the senior year of Military Science (MS IV), a student attends four class periods, plus drill during one term for which term course credit is given. During the remaining two terms of the senior year, students will attend two class periods, plus one drill per week (sustaining course). Upon completion of the Advanced Course, Military Science, the university will certify the total number of hours spent in pursuing the Reserve Officers' Training Corps program.

COURSE DESCRIPTION

Basic Course

10. AMERICAN MILITARY HISTORY. Term course. Four class hours and one drill period per week. Fall and winter terms.
12. UNITED STATES DEFENSE ESTABLISHMENT. Sustaining course. Two class hours and one drill period per week. Fall and winter terms.
13. ELEMENTARY MAP READING AND COMMUNICATIONS SYSTEMS. Elective term course. Two class hours and one drill period per week. Spring term. Prerequisites: 10 and 11.
21. ADVANCED MAP READING. Sustaining course. One class hour and one drill period per week. Fall term.
22. ADVANCED MAP READING AND AERIAL PHOTOGRAPHY. Sustaining term course. One class hour and one drill period per week. Winter term. Prerequisite: 21.
23. INDIVIDUAL WEAPONS AND MARKSMANSHIP. Elective term course. Two class hours and one drill period per week. Spring term. Prerequisites: 21 and 22.

Advanced Course

111. PRINCIPLES OF LEADERSHIP. Sustaining course. Two class hours and one drill period per week.

112. MILITARY TEACHING METHODS. Sustaining course. Two class hours and one drill period per week. Prerequisite: 111.

113. SMALL UNIT TACTICS AND COMMUNICATIONS. Term course. Two class hours and one drill period per week. Prerequisites: 111 and 112.

121. OPERATIONS AND LOGISTICS. Sustaining course. Two class hours and one drill period per week.

122. LOGISTICS. Sustaining course. Two class hours and one drill period per week.

123. LEADERSHIP AND MANAGEMENT. Four class hours and one drill period per week.

One lower division term course (MS 10) and one upper division term course (MS 123) will be credited against the number of term courses required for graduation.

Two lower division term courses (MS 13 and MS 23) would be used by students as elective courses which would be in addition to those required for graduation. These will be applicable towards academic credit and will be included in the determination of grade point average.

One upper division term course (MS 113) will be taken under the "Pass-Fail" policy. This course, graded Pass or Fail will be reported on the student's transcript, but will not affect his grade point average.

All sustaining courses must be taken to satisfy the requirements for an officer's commission in the U.S. Army.

RESERVE OFFICERS' TRAINING CORPS

FACULTY

FRANCIS X. LEARY, COLONEL (1968)
Professor of Military Science
M.A., 1963, George Washington University

JOHN D. SHANNON, MAJOR (1967)
Assistant Professor of Military Science
B.S., 1957, United States Military Academy

GLENN L. WISE, MAJOR (1968)
Assistant Professor of Military Science
B.S., 1961, Louisiana State University

WILLIAM H. DELANEY, CAPTAIN (1968)
Assistant Professor of Military Science
B.A., 1962, Washington State University

WAYNE A. RUSH, CAPTAIN (1968)
Assistant Professor of Military Science
B.A., 1963, San Jose State College

JOHN GARDINER, JR., SERGEANT MAJOR (1964)
Instructor in Military Science

EDWIN L. MOODY, MASTER SERGEANT (1966)
Instructor in Military Science

JOSEPH KULIG, STAFF SERGEANT (1967)
Supply Sergeant

KENDALL C. TURNER, STAFF SERGEANT (1967)
Instructor in Military Science

MALCOLM E. NEWTON, STAFF SERGEANT (1967)
Instructor in Military Science

SECTION III

SCHOOL OF ENGINEERING

DEGREES AND COURSE DESCRIPTIONS

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SCHOOL OF ENGINEERING

ADMINISTRATIVE OFFICERS

THOMAS D. TERRY, S.J., PH.D. ..... President
JAMES ALBERTSON, S.J., PH.D. ..... Academic Vice-President
ROBERT J. PARDEN, PH.D. ..... Dean of Engineering

AIMS

"...it is a Catholic school, yet those of other faiths are admitted also, and their religious opinions are not interfered with...to cultivate the heart...a care of morals, no less than intellectual improvement, are duties kept sacredly in view...." John Nobili, S.J., first President of the University of Santa Clara.

To these goals of fundamental knowledge — an inquiring mind, good habits of self-discipline, aptly expressed by Santa Clara's first president — the professional school adds the requirement of preparation to make a specific social contribution. Engineering knowledge was once passed from generation to generation in the familiar pattern of the apprenticeship. With the increasingly complex applications of science which provided the groundwork for the Industrial Revolution, those who were charged with applying science to the needs of the society in which they live — engineers — turned to the universities for increased formal preparation in science and mathematics. To accelerate the rate at which knowledge of contemporary engineering applications could be learned above that of the apprenticeship, schools of engineering developed — extending the curriculum beyond science and mathematics to include the methodology of engineering applications. Not only were the traditional goals of the University embraced, but to them were added specific professional needs — needs not only of the individual, but of the profession he represents.

The function of engineering is to bridge science and society; to modify nature to meet the needs of society within the restrictions dictated by social, political, and economic considerations.

In order to act as the bridge between science and society, the engineer must be both knowledgeable in science and sensitive to the means which can be used to satisfy social needs.

The rapid expansion of knowledge and complexity in all areas of science and engineering suggests the need to both broaden the educational program and to increase specialization. Both goals cannot be accomplished in four years. Because of the wide variety of engineering opportunities, and because so many graduates determine to go on for further study, the School of Engineering undergraduate curriculum minimizes specialization and combines it with general study in the humanities and the social and natural sciences.

Students who desire an even more liberalized approach to engineering education may elect the Bachelor of Science in Engineering degree program which permits additional courses in the life sciences, business administration, or the social sciences.

One-third of those students who earn Engineering degrees undertake graduate work in engineering. An additional group pursues graduate work in law, medicine, business administration, city and regional planning, and other areas where an undergraduate preparation combining science, applied science, and the liberal arts is desired.

The engineering activity requires all types of people with different interests, preparations, and abilities. Regardless of the field of engineering, there is a pattern of assignments describing the kinds of jobs in which engineers engage. These include:

Technical Management in which the engineer directs a team of engineers—technicians, mechanics, and other skilled artisans.

Consulting in which the engineer alone, or as part of a firm, offers his services to a client needing professional counsel.

Design in which the engineer plans structures or systems, using his knowledge of scientific principles and the properties of materials.

Research and Development in which the engineer seeks additional knowledge about basic, physical phenomena and develops this knowledge into a product or service. In this assignment the engineer works closely with the scientist, and often their division of labor is difficult to identify.

Construction and Production in which the engineer translates the design engineer's drawings and specifications into structures, machines, or systems.

Teaching in engineering schools and colleges.

These are general assignments. Engineers also undertake assignments which require engineering background and experience, such as administration, management, and sales.

DEGREES

The undergraduate programs lead to Bachelor of Science degrees in Civil, Electrical and Mechanical Engineering and a more general

program for the Bachelor of Science in Engineering degree. At the Master of Science level, degrees may be earned in Civil, Electrical and Mechanical Engineering, Engineering Mechanics, Applied Mathematics and Engineering.

The Engineer's degree, which represents a year of study beyond the Master's degree, may be earned in Electrical or Mechanical Engineering. The Doctor of Philosophy degree is granted in Electrical Engineering.

ALLIED OCCUPATIONS

To be able to narrow one's interest in a career to a specific program, such as Engineering, it is necessary to recognize other kinds of assignments whose preparation follows different formal avenues from that of Engineering. For example:

The Scientist is interested in basic relationships and has an intense curiosity about nature. His discoveries are the raw material for the engineer's applications. A career in science normally is associated with the work of the physicist, the chemist, the biologist, and other assignments in basic science. The preparation for these careers differs from that of the engineer.

The Mathematician is concerned primarily with mathematics as precise description and with construction of mathematical models of physical situations. His contribution to engineering is interpretation, prediction, and application of generalized expressions to specific situations. Here, again, the work of the mathematician and the engineer overlap considerably. Many kinds of engineering assignments require a considerable sophistication in mathematics. It is in the concern for applications that the attitude of the engineer and the mathematician differ. The mathematician may often be more interested in mathematics as a science than he is in applications which might utilize mathematics.

The Technician is one of the men who works with engineers. His interest is practical, and generally he does not need the same amount or kind of formal education. Primarily his job is to gather data and assemble accumulated experience for application to specific and, sometimes, repetitive problems.

The Mechanician or Craftsman is concerned with shaping or forming raw materials into useful forms. He fabricates parts, assembles machines, often installs, tests, and maintains equipment. His preparation normally involves the development of a high degree of manual skill.

ENGINEERING AT SANTA CLARA

The undergraduate programs leading to the Bachelor of Science in Civil, Electrical, and Mechanical Engineering were first offered at the University of Santa Clara in 1910. They were accredited by The Engineers Council for Professional Development in 1937. Since that time, the Bachelor of Science in Engineering, the Master of Science in Civil, Electrical, and Mechanical Engineering, in Engineering Mechanics, in Applied Mathematics, the Master of Science in Engineering, the Engineer's degree in Electrical, Mechanical, and Engineering Mechanics, and the Doctor of Philosophy in Electrical Engineering programs have been added.

FACILITIES FOR ENGINEERING

The School of Engineering's laboratories are contained in three buildings in the Sullivan Engineering Center built in 1960. A lecture, seminar, and office building is planned to complete the School of Engineering complex.

CIVIL ENGINEERING LABORATORIES

The Mechanics of Materials Laboratory contains testing machines which have a maximum capacity of 200,000 pounds. Hardness, fatigue, impact, torsion testing and photoelastic equipment are used for instruction and research. A wide selection of electric strain-gaging apparatus is available for static, dynamic, and repeated loads. These include regular and recording oscilloscopes, low-frequency strain recorders, and static strain indicators.

The Soil Mechanics Laboratory is equipped with the most recently developed apparatus for the physical testing of soils. The laboratory contains consolidation devices and triaxial compression testing units equipped for controlled stress, controlled strain, or cyclic loading, and equipment for sample preparation, permeability tests, laboratory compaction of soils, and determination of water content, specific gravity, and consistency limits.

ELECTRICAL ENGINEERING LABORATORIES

Laboratories and facilities are available for research and instruction in electrical machinery, electric controls and servomechanisms, computing, electrical measurements, electronics, and communications. Electrical power over wide ranges of frequency and voltage is available in every laboratory.

The Computing Laboratory contains a general purpose analog computer, recording and other accessory equipment. The analog computer provides the necessary facilities for the analysis of a wide variety of dynamical problems. The development of new computing devices and techniques is a part of this laboratory's activity. Experimental procedures are developed in laboratory sessions.

In addition to this analog computer facility within the Department, a general purpose digital computer is located nearby. Computing time is available for regularly scheduled instructional classes and for the research activities of graduate students and the Engineering faculty.

The Electronics and Communications Laboratories provide modern facilities in electronics, wire communications, radio communication, and microwaves. These laboratories are equipped with signal generators, oscillators, precision bridges, cathode-ray oscilloscopes, Q-meters, a wave analyzer, an artificial transmission line, and other precision measuring equipment.

The Control Systems Laboratory is well-equipped with modern instruments for experimental studies of individual control-system components and of complete systems. In addition to the usual electronic test equipment, there is equipment for construction and test of many types of servos, modern oscillographic recorders, and numerous analog and digital components. From time to time additional special-purpose test equipment is constructed to facilitate studies of adaptive control systems, digital control systems, and carrier control systems, among others. This equipment is frequently supplemented by the use of analog and digital computers located in adjacent laboratories.

The interdisciplinary program in bioengineering utilizes facilities in Engineering, Biology, and Chemistry on campus; the medical research facilities of an adjacent hospital are appropriate for certain research interests.

MECHANICAL ENGINEERING LABORATORIES

The Mechanical Engineering Laboratories include bench laboratories and a high-bay facility for experimentation in free-fall systems, fluid mechanics, thermodynamics, heat and mass transfer, propulsion, combustion, power generation, and air conditioning.

A variety of internal combustion engines installed on dynamometer stands can be used for studies in diesel and spark-ignited engine performance. An axial-flow fan with adjustable blades attached to a wind tunnel permits a variety of experiments to be performed in aerodynamics and turbomachinery. A flame tube with photoelectric sensors is

available for combustion studies. A shock tube with a 3″ by 3″ section is used to study shock-wave phenomena.

The fluid dynamics area contains equipment to illustrate the principles of fluid flow and to familiarize the student with basic elements of hydraulic machinery and their associated instrumentation. Each device may be supplied directly from a pump or from a constant level standpipe with a 35-foot head.

Included in the Mechanical Engineering Laboratories is the equipment associated with electro-mechanical energy conversion. A variety of direct- and alternating-current machines, transformers, and associated equipment is available.

A unique approach is made in utilization of a complete metal-processing facility. The first course in this area is taught by an engineer in order that the students become familiar with machine-tool processes from an engineering design point of view. The student further utilizes the shop facility during his thesis activities. The facility is also utilized for construction and maintenance of experimental apparatus.

DATA PROCESSING CENTER

The Data Processing Center of the University is located in the Sullivan Engineering Center. IBM 1130 and 1401 digital computers are used for teaching and research by faculty members and students. Introduction to computer programming is part of the freshman design course. Several undergraduate courses require the use of this facility as part of their regular laboratory. Other computer facilities are available in the Electrical Engineering Laboratories.

THE UNDERGRADUATE PROGRAM

The Bachelor of Science degree programs in Civil, Electrical, and Mechanical Engineering and the Bachelor of Science in Engineering program are planned around a common core of courses which will provide:

1. A thorough preparation in the basic sciences of physics, chemistry, and mathematics.
2. The general application of these sciences as developed in the engineering fundamentals: mechanics of solids and fluids, properties of materials, thermodynamics, electricity, and magnetism.

3. Assistance in further developing the ability to communicate orally, and by written and pictorial presentations.

4. Study in the humanities, the social sciences, theology, and philosophy.

The professional subjects pertaining to the analysis, synthesis, and design sequences in Civil, Electrical, and Mechanical Engineering are developed primarily in the upper division. A combination of these or other subjects may be developed for other degree objectives.

Admission as a Freshman

Applications for the freshman class in Engineering are accepted from both men and women students. The class is selected from the applicants on the basis of (a) achievement in high-school subjects with special reference to mathematics and science, (b) results of the College Entrance Examination Board tests, (c) recommendations, and a personal interview when this is feasible. Specific instructions for undergraduate applications are described elsewhere in this publication and on the application form which may be obtained from the Office of Admissions. Applications to take the Entrance Examinations must be made directly to the College Board. The specific requirement in each of these categories is described below.

Applicants must be graduates of an accredited high school and must present no less than sixteen units including the following:

English	3	Trigonometry	½
Foreign Language (one language)	2	History	1
Algebra	2	Chemistry	1
Geometry	1	Physics	1
		Unprescribed	4½

It is strongly recommended that the unprescribed units be in mathematics, languages, natural or social sciences. Applicants who offer a list of subjects not in accordance with the above will be admitted at the discretion of the Admissions Committee, based on their College Entrance Examination achievement and their high-school record.

Entrance Examinations

All applications for admission to the freshman class in Engineering are required to take the following College Entrance Examination Board tests:

1. The Scholastic Aptitude Test.

2. Achievement Tests in Math I, English, physics, or chemistry.

The Entrance Examinations are given by the College Entrance Examination Board and are offered at many locations throughout the world. Students living in the West should write to Educational Testing Service, 1947 Center Street, Berkeley, California, requesting the application form and information on examination dates and locations. Students living in the East should write Educational Testing Service, P. O. Box 592, Princeton, New Jersey.

Examinations may be taken on the same or different days, but all tests should be completed by January of the senior year in high school. The Board should be requested at the time the tests are taken to send the scores to the University of Santa Clara.

It is recommended that a test application form and test information be obtained from the College Entrance Examination Board not later than October of the senior year in high school.

Admission as an Honors Student

The University of Santa Clara Departmental Honors Program recognizes outstanding students majoring in each department. Freshmen entering with a high-school grade point of at least 3.5 and Scholastic Aptitude Test scores exceeding 1350 may apply for an interview with the Dean of the School of Engineering for admission to the program at entrance. The high schools from which accepted students enter will be notified of this designation.

Students who do not enter the Honors Program at entrance may apply for admission to the Honors Program if they maintain a B average.

The Honors Program is available for students of superior initiative and ability. It is not a program to recognize students of superior academic accomplishment; the Dean's Honor Roll, the scholastic honor fraternity Tau Beta Pi, and other accolades are reserved for this recognition. Rather, it is the opportunity for a student to undertake the additional challenge of courses and programs of independent study and research. The student may withdraw from the Program with permission at any time he has completed all of his current commitments and resume a regular degree program.

All Honors students will be allowed to (a) enroll in Scholars courses in other departments of the University; (b) enroll in department courses in independent study and research: 199; (c) participate in undergraduate research projects, particularly during the summer

months; (d) extend the scope of a thesis project of unusual merit; (e) make course substitutions of particular merit for professional goals.

Admission to Advanced Standing

Admission to advanced standing is by specific action of the Committee on Academic Standing, which will evaluate all credits presented and determine the rating of the candidate. Only students in good standing at the last college attended will be considered. No student on academic or disciplinary probation, or suspension, will be considered for admission.

The student normally will be able to complete a Bachelor's degree program in six terms if he presents 65 semester hours including the following minimum subject requirements:

	Minimum No. of Units
Analytical Geometry and Calculus	12
Chemistry (for engineering and science students)	7
Physics (for engineering and science students)	10
Freshman English 1A-1B	6
Liberal Electives (English, Economics, History, Social Studies, Languages)	12
Unspecified	18
Total	65

The Dean's Honor Roll

Each term, a list of those who have achieved an academic rank in the top 10 percent of their class will be published.

The Undergraduate Curriculum

The undergraduate degrees are earned by completion of 40 term courses (beginning with the class of 1972) in which an overall C (2.0) average must be earned. The courses listed below may be scheduled in different terms, depending upon the major department requirements.

Freshman

Mathematics 11	Mathematics 12	Mathematics 13
Chemistry 3	Chemistry 4	Physics 4
English 1	English 2	Engineering Major
	Design I	Free Elective

Sophomore

Mathematics 21	Philosophy	Liberal Elective
Physics 5	Physics 6	Free Elective
Liberal Electives* (2)	Liberal Elective	Engineering Major (2)

Junior

Electrical Engineering I	Strength of Materials	Engineering Major (2)
Engineering Major	Electrical Engineering II or II-C	Thermo-Fluid Mechanics II
Philosophy	Thermo-Fluid Mechanics I	

Senior

Liberal Elective	Liberal Elective	Engineering Major (3)
Engineering Major (2)	Engineering Major (2)	

The following courses are scheduled by those electing a specific degree program:

Civil Engineering: CE 10, 15, 20, 110, 116, 121, 130, 131, 133, 135, 140, 145, 148; Mathematics 22 or AM 118 or Mathematics 122.

Electrical Engineering: Physics 7; CE 111; AM 118; EE 104, 111, 112, 131, 151, 161, 198; and three electives.

Mechanical Engineering: Physics 7 or ME 15; CE 111 or CE 15 and CE 110; Math 22; AM 118; ME 11, 110, 111, 122, 135, 140, 198 and one elective. (Variations may be arranged with counselors.)

The Bachelor of Science in Engineering

The Bachelor of Science in Engineering degree allows a student to plan a program with different objectives than the programs in civil, electrical or mechanical engineering. Some of these objectives might include:

1. Medicine or related health sciences, sanitary or bio-engineering. Additional course work in biology and chemistry would be appropriate.
2. Graduate work in business administration. Courses in accounting, economics, business law and marketing will allow a student to move on to graduate school without course deficiencies.

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*Liberal Electives:
All Catholic students schedule two term courses in Theology.
All students must meet the American Institutions requirement by a noncredit examination, or by scheduling a designated course: Economics 12, 116; History 17; Political Science 1, 153. The remaining courses are elected with the advisor's approval.

3. Computer programming and data processing. Additional courses in applied mathematics can be scheduled.
4. Teaching in secondary schools. Additional courses in mathematics and science will insure obtaining a teaching credential in one additional year.
5. Graduate work in public administration. Courses in political science, creative arts, history of architecture can be arranged.
6. Law school has been a traditional interest of many engineers.

These programs will normally be planned no later than the junior year to insure that the degree requirements and the courses of special interest can be scheduled. Students enrolled in all of the courses taken by all engineers through the second term of the junior year. In the remaining four years, the twelve courses should include:

One humanities elective

Three courses in an engineering design sequence selected from the Civil, Electrical or Mechanical program. A typical sequence might include: ME 110, 111, 140; ME 122, 135, 136; EE 111, 112, 131; EE 151, 152, 131; CE 130, 131, 133; or CE 140, 142, 145. A thesis is required and credit for it may be substituted for one of these courses.

Three additional term courses in Mathematics, Science or Engineering.

Five term courses which contribute to some degree objective.

A course plan should be submitted for approval by a member of the engineering school faculty to insure that the requirements for the degree are satisfied.

Normal Time Requirements

The average student will be able to complete a degree program in 12 terms. Those students who must assume part-time off-campus jobs, or who add additional programs to the Engineering program, will require additional terms. The curricula in Engineering require 40 courses for graduation and a cumulative 2.0 average. Seven term courses taken in the last three regular terms of attendance at the University shall constitute residence requirements for a degree.

Senior Thesis

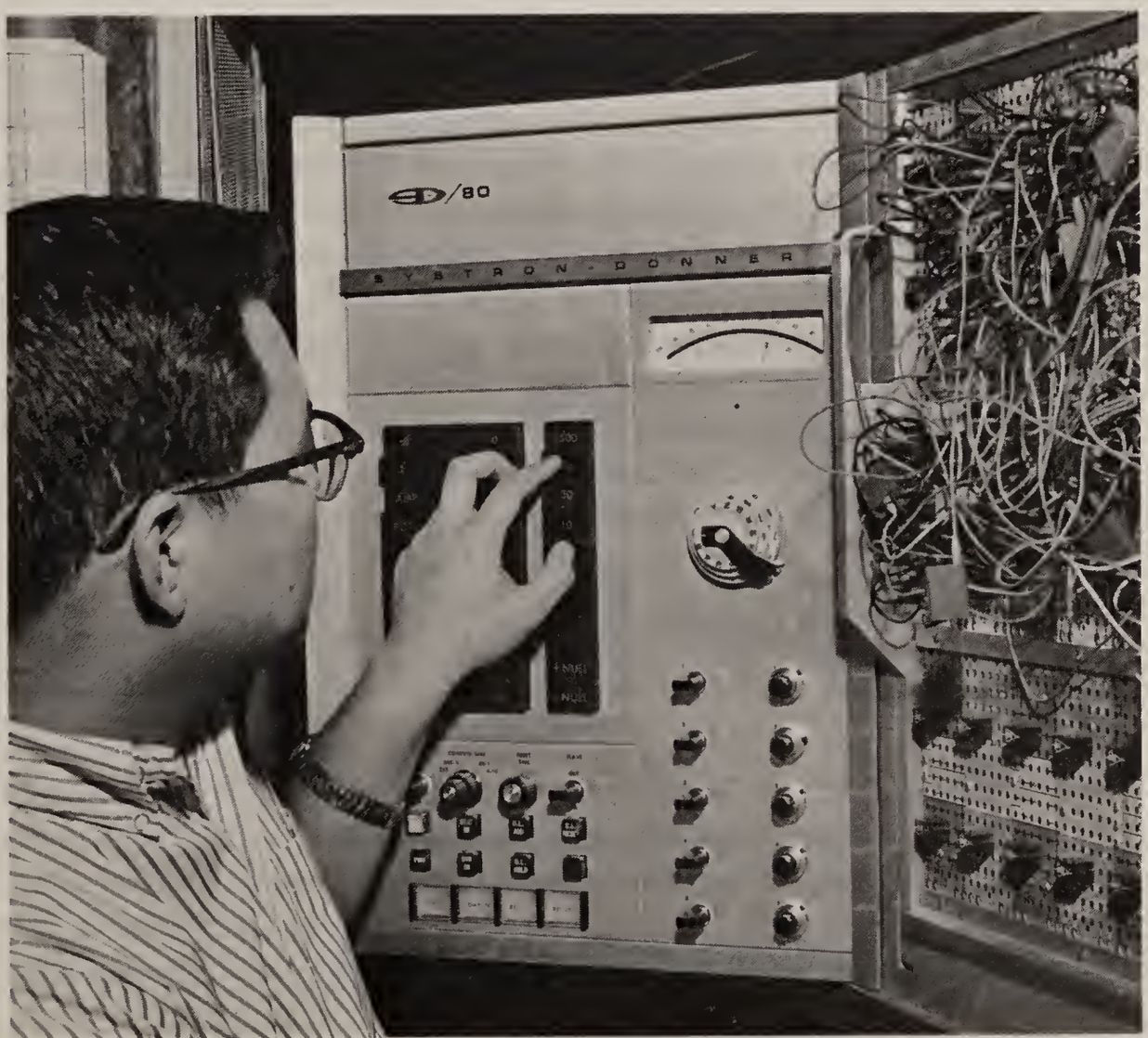
All students seeking a degree in Engineering are required to submit a thesis during their senior year.

The senior thesis provides a student with the opportunity to carry out an original investigation in an orderly fashion, the momentum of progress being supplied primarily by the student's enthusiasm, interest, and effort. The project is scheduled throughout the senior year and must be submitted before the student is admitted to his final examinations.

It is felt that a good undergraduate thesis:

1. Should involve an element of originality. It should be an investigation on the frontier of the student's knowledge.
2. Should require an element of design, an element of equipment assembly and utilization of instrumentation and a test program.
3. Should include successful evaluation of results utilizing sound test techniques and application of fundamentals of engineering. It is desirable that the evaluation require an extension of previous information to cope with the thesis project.

The Department chairman appoints a thesis advisor. The advisor will approve the thesis subject and method of approach, the outline of the thesis, initial drafts and final copy of the thesis as the project develops.



THE GRADUATE PROGRAM

The School of Engineering offers graduate work leading to the Master of Science degree in Electrical and Mechanical Engineering, Engineering Mechanics, Applied Mathematics, and the Master of Science in Engineering. The Engineer's Degree is awarded in Electrical, and Mechanical Engineering and in Engineering Mechanics. The Doctor of Philosophy degree may be earned in Electrical Engineering.

While most graduate students have undergraduate preparation in an engineering curriculum, it is feasible to enter from chemistry, physics, or mathematics. The amount of undergraduate work which must be undertaken before the degree program is dependent upon the specific preparation and the degree sought.

Master of Science Program

Admission to Graduate Standing

Application for admission to graduate work should be made to the Dean of the School of Engineering on the form available from that office. Official transcripts of record covering all college and university work completed to date, together with official evidence of degrees conferred, must be received prior to admission as a graduate student. Two separate, original and official records must be presented from each institution previously attended.

Students will be admitted to Degree candidacy at initial enrollment at Santa Clara if they:

1. Received their Bachelor's degree in Engineering from an ECPD accredited four-year program substantially equivalent to that of Santa Clara, and plan to undertake a graduate program in the same field.

2. Accomplished a scholastic average of at least 2.75 (based on a 4.0 maximum) in the technical work of the last two undergraduate years.

3. Submit their application and supporting credentials at least six weeks before registration for the semester of initial enrollment.

4. Develop a program of studies with their assigned advisor before registration and file it with the Dean of Engineering.

Students who have earned a Bachelor's degree in a four-year engineering, science, or mathematics program substantially equivalent to that of Santa Clara but who do not initially meet the Degree Candidate requirements, will be allowed to enroll for graduate work at the discretion of the Graduate Admissions Committee. The School reserves the right to deny admission if the previous program has not been of such character as to furnish an adequate foundation for advanced academic study. In order to insure processing of applications, they must be received, together with transcripts of previous work, at least four weeks before registration for the initial enrollment. Material received later may prevent or delay registration and subject the student to the late registration fee.

When the unclassified graduate student has completed 15 quarter-hours of work at Santa Clara, and he has eliminated all assessed undergraduate deficiencies, he may apply for Degree Candidate classification. Since a 3.0 grade-point average is required to receive the Master's degree, the application will not be approved if the applicant's scholarship accomplishment is below 3.0 in all courses taken at Santa Clara. Upon becoming a Degree Candidate, students will be assigned a major-field advisor and should arrange a conference with him to develop a Program of Studies.

Program of Studies

A Program of Studies must be developed with the approval of the major department and filed with the Dean of Engineering. It is a plan of study which, when satisfactorily completed, will merit the receipt of the appropriate degree. It should be filed during the first term enrollment of each student who receives graduate status.

Master's Thesis

All students who seek the Master's degree and are enrolled on a full-time basis must submit a Master's Thesis unless specifically exempt. Students who wish to substitute course work must receive written permission from the major department to make this substitution.

Master's Degree Requirements

The Master's degree will be granted to degree candidates who complete a program of studies which has been approved by the major department. It must include no less than 45 quarter-hours of which nine may be earned by completing a thesis. In addition, a quality level of 3.0 (a B average) must be earned in course work taken at Santa Clara while enrolled in the Graduate Degree Program. Resident requirements of the University will be met by completing 36 quarter-hours of the graduate program at Santa Clara. All units applied toward the degree, including those transferred from other institutions, must be within a six-year period.

All degree candidates must file a degree application with the Dean of the School of Engineering at least two months before the day on which the degree is to be granted. A degree application form may be obtained from the same office.

Department Requirements

Civil Engineering and Engineering Mechanics

The program in Civil Engineering emphasizes the field of Engineering Mechanics; consequently, the degree may be taken in Civil Enginneering or Engineering Mechanics. The following courses must be taken by every candidate for the Master's degree. Adjustment of this requirement may be made in special cases.

AM 130	Applied Mathematics I
CE 150	Advanced Strength of Materials I.
CE 154	Statically Indeterminate Structures I
CE 157	Theory of Plates.
CE 158	Theory of Shells I.
CE 165	Dynamics of Structures I.
CE 168	Theory of Stability of Structures I.

Electrical Engineering

The following courses must be taken in order to be eligible for the Master's degree in Electrical Engineering. Adjustments of this requirement may be made in special cases.

Three Advanced Mathematics Courses including AM 135.

Two Advanced Physics Courses.

One Graduate Course in Electromagnetic Fields: EE 201.
One Graduate Course in Modern Network Analysis or Synthesis.
One Graduate Course in Control Systems.
One Graduate Course in Electronic Circuits.

Eighteen units of electives, selected with the approval of the Department, will allow concentration in the following areas of study: networks, controls, digital systems, electronic circuits, or field theory and applications.

The candidate is required to pass an oral comprehensive examination before completing the requirement for the degree.

Mechanical Engineering

A program of studies to meet the interest of the individual should be developed with a member of the Department. Candidates for the Master's degree must submit their proposed program for departmental approval upon filing for candidacy status. The program must contain at least 6 units in advanced mathematics and one course in modern physics.

Master of Science in Engineering

This program was initiated to accommodate those who wish to seek goals which do not fall within the patterns of the designated degree programs. A program which combines engineering, mathematics, and the physical and life sciences might be a desired plan. The program must be made up of courses in engineering, mathematics, or science; approved by an advisor, and filed at the time degree candidacy is sought.

Master of Science in Applied Mathematics

The Applied Mathematics program is open to those students who have earned a B.S. degree in Engineering, Science, or Mathematics. A minimum of 36 quarter-hours of mathematics must have been completed. The undergraduate preparation must include courses through the calculus (16 quarter-units), differential equations (4 quarter-units), advanced calculus (4 quarter-units), algebra (modern algebra, linear algebra or matrix theory) (4 quarter-units), complex variables (4 quarter-units). The remaining hours may be satisfied by courses in applied mathematics or analysis.

The courses for the Master's degree must include no less than 30 quarter-hours in Applied Mathematics of which a minimum of 12 quarter-units must be in 200-level courses. The balance of the program may be in related areas in engineering or physics.

Before admission to candidacy for the degree of Master of Science in Applied Mathematics, all students must pass a preliminary examination on basic mathematics in the area of differential and integral calculus, differential equations, applied mathematics (Fourier Series and Laplace Transforms) and complex variables. This examination may be taken any time after admission to the graduate school but must be taken before application for candidacy for the Master's degree.

The Bioengineering Program

Students seeking a Bachelor or Master of Science degree in Electrical or Mechanical Engineering or Doctor of Philosophy degree in Electrical Enginering may choose to pursue the Bioengineering program.

Undergraduates in the Bioengineering Program must take EE 171 and three upper-division courses in the Biology Department. In addition, their Senior Thesis must be directly related to a biological problem.

Applicants for the Master's program must complete EE 271, 272, 273, 274 and 279. They may also choose graduate courses from the areas of system theory, computers, applied mathematics and information and communication theory according to their individual needs and interest. In addition, their Master's Thesis must be directly related to a biological problem.

Applicants for the doctoral degree will choose a program of studies appropriate to their individual interest. The Doctoral Thesis must be directly related to a biological problem.

The Engineer's Degree Program

The program leading to the degree of Engineer is particularly designed for the continuing education of the practicing engineer. It is offered in Electrical and Mechanical Engineering, and Engineering Mechanics. The degree is granted upon completion of an approved academic program and a record of acceptable technical achievement in the candidate's field of engineering. The academic program consists of a minimum of 45 quarter-units beyond the Master's degree. Courses are selected to advance the engineer's competence in specific areas relating to his professional work. Evidence of technical achievement must include a paper authored principally by the candidate and of such quality as to be published in a recognized engineering journal. All papers must be submitted to appropriate journals at the time they are submitted to the department.

Admission to the program will in general be granted only to those students who demonstrate superior ability in meeting the requirements for their Master's degree. Normally, the Master's degree would be

earned in the same field as that in which the Engineer's degree is sought.

A program of studies for the Engineer's degree should be developed with the assistance of an advisor and submitted during the first term of enrollment. An application for degree candidacy must be submitted prior to the completion of ten quarter-units of course work.

Students should consult the departments for specific degree requirements.

The Doctor of Philosophy Program

The degree of Doctor of Philosophy is conferred by the School of Engineering primarily in recognition of competence in the subject field and the ability to investigate engineering problems independently. The work for the degree consists of engineering research and the preparation of a thesis describing it, and a program of advanced studies in engineering, mathematics, and related physical sciences. The student's work is directed by the department, subject to the general supervision of the School of Engineering.

Requirements for Admission to the Doctoral Program

All applicants for the doctoral program are required to take the advanced Engineering Test of the Graduate Record Examination administered by the Educational Testing Service, 4640 Hollywood Boulevard, Los Angeles, California 90027, or 20 Nassau Street, Princeton, New Jersey 08540. The Testing Service must be requested to forward the results to the Dean, School of Engineering. An academic achievement of the Master's level, or its equivalent, is required of all applicants. Students who have earned the Master's degree from the University of Santa Clara must file a new application to continue work toward the Doctor's degree.

All applicants for doctoral degree programs who have been admitted by the Engineering School to advanced standing shall present themselves for preliminary examinations by their major department at such times as shall be set by the departments. These examinations shall be written and/or oral and shall include fundamentals of mathematics and the physical sciences, as well as engineering subjects.

Only those applicants who have shown sufficient background and promise in the preliminary examinations shall be accepted as doctoral candidates. The preliminary examinations may be repeated only once, and then only after one year.

The applicant should:

1. Submit an Application for Admission to the Engineering School.
2. Submit a list of three references who can attest to the potential of the candidate.

3. Submit a 500-word biography indicating the applicant's academic, research, and professional goals.
4. Submit, *if requested,* copies of theses, papers, or reports written by the applicant.
5. Submit copies of transcripts of academic records at all universities attended. Please request the Registrar of each university to forward the transcript directly to the Dean, School of Engineering.

Registration

Students are required to file a program of studies with the Department during the first semester of attendance. This program must be approved by the Graduate Programs Committee. The student's advisor must approve the portion of the program to be undertaken each quarter, whether it is research, course work, or independent reading. An amended program must be filed to record any changes from the original program. Changes must be approved by the Graduate Programs Committee.

A student will not receive credit for a course unless properly registered. Units assigned for research shall be determined by the instructor. The instructor may reduce the number of research units for any term in which the anticipated research progress is not attained.

General Requirements for the Doctor's Degree

The Doctor's degree is granted primarily on the basis of achievement, rather than on the accumulation of units of credit. However, the candidate is expected to have completed three academic years of residence in a graduate program beyond the Bachelor's degree. Generally this is interpreted to mean a minimum of 135 quarter-units of graduate credit. Of these, a total of 45 may be earned as research credit for the Master's and Doctor's theses. Normally the remainder is earned through course work and independent study.

Residence: A minimum of eleven-months' full-time study must be undertaken at the University for the doctorate. The residency time shall normally correspond to the period of the oral examinations and the completion of the thesis. This may be accomplished in one calendar year or four full-time summer terms.

Admission to Candidacy: Upon completion of the formal course program of studies, as approved by the Graduate Programs Committee, the student shall present himself for comprehensive examinations on the subjects of his course work. The arrangements for the comprehensive examinations shall be initiated by the student through the Graduate Programs Committee.

Those students who have performed satisfactorily on the comprehensive examinations may apply for degree candidacy by submitting a formal letter of application to the Dean of the School of Engineering. This must be accompanied by a statement of intent of research supervision by the student's thesis advisor and a letter of recommendation by the Department Chairman. It shall be the student's responsibility to arrange for a thesis advisor.

The comprehensive examinations normally must be completed within five years from the time which the student has been admitted to advanced standing. Comprehensive examinations may be repeated only once.

Preparation for Research: The Doctoral candidate shall request his thesis advisor and the Department Chairman to form a Doctoral Committee. This committee shall consist of at least five members, including the thesis advisor and two additional members from the major department. The committee shall include two members from the Mathematics and/or Physical Science departments.

The Doctoral Committee shall determine language requirements, and any further studies which may be required.

Oral Examination: Within a period of three years after admission to candidacy, the student must normally make arrangements with the Doctoral Committee for the oral examination on his research and thesis. This examination shall be conducted by the Doctoral Committee and whomever they appoint as examiners. The thesis must be made available to all examiners one month prior to the examination. The oral examination shall consist of a presentation of the thesis, which shall not exceed forty minutes, and the defense of the thesis, which shall not exceed one hour. This examination shall be open to all faculty members of the University of Santa Clara and shall be announced two weeks prior to the examination date.

Thesis: At least one month before the degree is to be conferred, the candidate must submit to the Dean of the School of Engineering two copies, ribbon or reproduced, of the thesis describing his research in its entirety. The thesis shall not be considered as accepted until it has been approved by the Doctoral Committee, and until one or more articles based upon it have been accepted for publication by an acceptable professional or scientific journal.

The requirements for the Doctor's degree by the School of Engineering have been made to establish the structure in which the degree may be earned. Upon written approval of the Academic Vice-President, the Dean of the School of Engineering, and the Chairman of the Department, other degree requirements may be established. The Faculty of the University reserves the right to evaluate both the undertakings and

the accomplishments of the degree candidate in total and award or withhold the degree as a result of its deliberations.

Information for the Guidance of all Graduate Students

Standards of Scholarship

Only courses in which the student has assigned grades of A, B, or C may be counted in satisfaction of the requirements for the Master's degree. The student must earn a 3.0 average in all courses taken at Santa Clara as a graduate student to be eligible for the degree. Only credit, and not grade-points, are transferred from other institutions. The Dean of Engineering will request students to terminate enrollment when satisfactory progress towards a degree is not being maintained.

Readmission

An application for readmission is required of persons whose enrollment in the University lapses for two consecutive terms, not including summer terms. A regular admission form will be used with the readmission status marked on it. Applicants for readmission must submit transcripts of the latest graduate work completed in other departments of the University, together with official transcripts of study completed elsewhere since the previous enrollment.

Academic Loads

It is recommended that work-study students limit their course load upon their initial registration to a maximum of four quarter-hours. Despite the convenience of the hours of class meeting, the additional time for study, plus other responsibilities, may lead to an overestimation of the quality of work that can be maintained under these conditions. Students enrolled under a work-study plan may not enroll for more than six quarter-hours. Students enrolling in more than six quarter-hours will be considered resident students and subject to the appropriate regulations.

Resident students with a research or teaching assistantship will not be allowed to enroll in more than twelve quarter-hours in any quarter, and no graduate student may exceed fifteen quarter-hours in any one quarter. Ten quarter-hours is considered the minimum load for full-time enrollment.

Graduate Assistantships, Loans

Both fellowships and teaching or research assistantships are available to qualified graduate students. Fellowships include the National

Science Foundation Graduate Traineeships in Engineering, the NSF Cooperative Graduate Fellowships, and The Summer Fellowship Program for Graduate Teaching Assistants. Grants are up to $2,400 for the nine-month academic year, plus tuition and a dependents allowance.

Stipends for teaching or research assistantships vary, depending on qualifications and on the work assignment. One-quarter time appointments (ten hours a week assigned duties) and one-half time appointments (twenty hours a week assigned duties) are available.

All applications for fellowships or assistantships must be submitted before March 15 preceding September enrollment. Notification will be given by April 15. Other closing dates may apply to specific programs. These will be indicated on supporting information sheets. Further information and application forms may be obtained upon request from the Office of the Dean, School of Engineering.

The University offers National Defense Act loans open to undergraduate and graduate students in need of financial assistance. Information regarding these loans may be obtained from the Director of Financial Aids, University of Santa Clara.

Courses Completed at Other Institutions

A maximum of nine quarter-hours of credit may be transferred from other institutions at the discretion of the Graduate Committee. Eligible courses include those taken as a graduate student in which a grade of B or better was earned.

Auditors

Students will be allowed to audit courses with the permission of the instructor in charge of the course and the Dean of the School. Tuition will be charged in the same manner as though it were registration for credit.

Foreign Students

Admission to graduate study is based on records of undergraduate work. If this study was in a language other than English, the individual's ability to undertake a program wherein the instruction is in English is difficult to determine. The University will strongly encourage review courses in English and appropriate undergraduate courses, not for graduate credit, when it feels that an individual's progress is suffering because of a language difficulty.

A foreign student who is accepted for enrollment in the University of Santa Clara will receive a certificate of acceptance, which he must show to the consular officer of the United States to whom he applies for a student visa. Foreign students must maintain an enrollment level of at least ten quarter-hours each term.

Graduate Student Housing

The University does not maintain dormitories for graduate students. Apartments and rooms are available adjacent to the campus in the City of Santa Clara. Meals may be taken in the Student Commons.

Tuition and Fees

An application fee of $15.00 is charged for the first enrollment in courses in the graduate program. This is paid only once. A tuition fee of $35.00 per quarter-hour will be charged for all courses, including Thesis. Auditors will be charged the same fees. For comprehensive written examinations, a fee of $10.00 will be charged for each examination. Graduation and Thesis binding fees will be assessed at the time application is made for the degree.

Refund of Tuition

Any student formally withdrawing prior to the fourth meeting of any regularly scheduled class will receive a refund of one-half of the tuition for that class. No refunds will be made subsequent to the fourth meeting. The date on which written notice of withdrawal is received by the Dean of Engineering will determine the refund, not the date of last attendance by the student.

The undergraduate school is on a term-course basis, and the Bachelor's degree requirements are stated in term courses. Credit for graduate courses are stated in quarter-hours and are shown in parentheses following each course title. A term course in the lower division (four at the same time) is equivalent to four quarter-units. A term course taken in the upper division—the junior and senior years (three courses at a time)—is equivalent to five quarter-units. The Bachelor degree requirement of 40 term courses is therefore equivalent to 186 quarter-hours or 124 semester-hours if conversion to other systems is desired.

APPLIED MATHEMATICS (AM)

GERALD MARKLE, PH.D., *Coordinator*

Professor: GERALD MARKLE

Lecturers: AGOSTINO BURZIO, CHARLES H. CHICKS, RAUL J. CONTI, DANIEL L. DREW, FRANK D. FAULKNER, WADE H. FOY, HENRY D. FRIEDMAN, GENE B. GALE, JOHN M. HARDING, EDWARD R. MEYER, PAUL O. SCHEIBE, JOSEPH H. SCHODERBEK, JEROME G. SOWUL

The Applied Mathematics faculty is composed of faculty from departments in the University, including Mathematics, Engineering, Chemistry, and Physics. Certain of the courses listed below are also taught in the Department of Mathematics' degree programs. They are included in the following list of Applied Mathematics because they will be made available to graduate students in the Early Morning Graduate Engineering Program.

All applied mathematics courses on the 100 level (except AM 101 and AM 102) are assumed to be first-year graduate courses. The minimum preparation for these courses is a working knowledge of the calculus and a course in differential equations. A course in advanced calculus is desirable. The 200 level courses are graduate courses in mathematics which should only be taken by students who have completed several 100 level courses in mathematics.

10. BASIC PROGRAMMING
Fortran and Cobol languages. Stored program concepts. Algebraic models, arrays, subroutines, elementary applications.

101. DIFFERENTIAL EQUATIONS I (2) Not for Graduate Credit
Differential equations in general, first order and simple higher order ordinary differential equations; applications of first order and higher order differential equations.

102. DIFFERENTIAL EQUATIONS II (2) Not for Graduate Credit
Linear differential equations with constant coefficients, applications, systems of differential equations and their applications;

linear equations with variable coefficients, existence and uniqueness of solutions to n-th order equations and systems of equations. Prerequisite: AM 101.

104. ADVANCED CALCULUS I (2)
Topics selected from: real number systems, continuous functions, extension of law of mean, functions of several variables, elements of partial differentiation, implicit function theorems, transformations and mappings, multiple integrals.

105. ADVANCED CALCULUS II (2)
Continuation of AM 104.

108. PROBABILITY AND STATISTICS (4)
Definitions of probability, sets, sample spaces, conditional and total probability, random variables, distributions, functions of random variables, sampling, estimation of parameters, testing hypotheses.

110. INTRODUCTION TO PROBABILITY I (2)
Definitions, sets, conditional and total probability, the binomial distribution approximations, random variables, important probability distributions, functions of random variables, moments, characteristic functions, joint probability distributions, marginal distributions, sums of random variables-convolutions, correlation, sequences of random variables, limit theorems.

111. INTRODUCTION TO PROBABILITY II (2)
Continuation of AM 110.

112. INTRODUCTION TO PROBABILTY THEORY (4)
A combination of AM 110 and AM 111.

114. ENGINEERING STATISTICS I (2)
Frequency distributions, sampling, sampling distributions, univariate and bivariate normal distributions, analysis of variance, two- and three-factor analysis, regression and correlation, design of experiments.

115. ENGINEERING STATISTICS II (2)
Continuation of AM 114.

116. ENGINEERING STATISTICS (4)
A combination of AM 114 and AM 115.

118. NUMERICAL AND OPERATIONAL METHODS
Fundamentals of Fourier and Laplace integrals and applications of Laplace transforms. Partial fraction expansion and pole-zero analysis. Fortran programming concepts. Numerical solution of algebraic and transcendental equations, finite differences, numerical differentiation and integration, and solution of ordinary differential equations. Solution of representative problems on the digital computer and analog computer simulation. Prerequisite: Differential Equations.

120. NUMERICAL ANALYSIS I (2)
Solution of algebraic and transcendental equations, finite differences, interpolation, numerical differentiation and integration, solution of ordinary differential equations, matrix methods with applications to linear equations, curve fittings, programming of representative problems for the IBM 1130. Prerequisites: AM 102 and ability to program in Fortran.

121. NUMERICAL ANALYSIS II (2)
Continuation of AM 120.

125. VECTOR ANALYSIS I (2)
Algebra of vectors. Differentiation of vectors. Partial differentiation and associated concepts. Integration of vectors. Applications. Basic concepts of tensor analysis.

126. VECTOR ANALYSIS II (2)
Continuation of AM 125.

128. INTRODUCTION TO APPLIED MATHEMATICS
Model making. Derivation of differential equations from physical laws. Role of approximation and linearization. Nonlinear differential equations. Introduction to difference equations. Introduction to optimization techniques.

130. APPLIED MATHEMATICS I (2)
Power series solution of differential equations, legendre polynomials, Bessel functions, Gamma and Beta functions, line and surface integrals. Prerequisite: AM 102.

131. APPLIED MATHEMATICS II (2)
Orthogonal functions, Fourier series, Euler's equations, even and odd functions, half-range functions, Laplace transforms, basic transforms, application. Prerequisite: AM 102. (Note: AM 130 and AM 131 may be taken in either order.)

132. APPLIED MATHEMATICS III (2)
Partial differential equations, separation of variables, Laplace transforms methods applied to the solution of partial differential equations. Prerequisites: AM 130 and AM 131.

135. COMPLEX VARIABLES I (2)
Algebra of complex numbers, calculus of complex variables, analytic functions, harmonic functions, power series, residue theorems, application of residue theory to definite integrals, conformal mappings.

136. COMPLEX VARIABLES II (2)
Continuation of AM 135.

140. MODERN ALGEBRA I (2)
Introduction to postulational systems, integers as an integral domain, study of rational, real and complex number fields, poly-

nomial forms and functions, introduction to group theory, vectors and vector spaces, algebra of matrices, rings and ideals.

141. MODERN ALGEBRA II (2)
Continuation of AM 40.

145. INTRODUCTION TO MATRICES I (2)
Matrix algebra, determinants, the inverse of a matrix, rank and equivalence, linear equations and linear dependence, vector spaces and linear transformations, unitary and orthogonal transformations, the characteristic equation of a matrix.

146. INTRODUCTION TO MATRICES II (2)
Continuation of AM 145.

150. INTRODUCTION TO MATHEMATICAL ANALYSIS I (2)
The real number system, set theory, function theory, real point set topology, limits, continuity, differentiation, partial differentiation, introduction to Riemann-Stieltjes integration.

151. INTRODUCTION TO MATHEMATICAL ANALYSIS II (2)

170. OPTIMUM SEEKING METHODS I (2)
A study of optimization techniques with emphasis on experimental methods. Necessary and sufficient conditions for extreme of functions. One-dimensional search methods. Steepest ascent, partan, conjugate gradient and ridge-acceleration techniques. Prerequisite: Ability to program in Fortran.

172. LINEAR PROGRAMMING
Mathematical optimization and decision techniques. Simplex and transportation tableau.

174. PROGRAMMING METHODS
Programming system description, design of subroutines; search, sort and file procedures; input/output conversion and editing, channel operation, interrupt techniques.

176. SYSTEMS ANALYSIS
Methods of application definition, hardware selection criteria, functional specification formulation, hardware and software system tradeoffs.

201. THEORY OF FUNCTIONS OF A COMPLEX VARIABLE (2)
Complex integration, calculus of residues, power series, conformal representation applications. Prerequisite: Elementary course in Complex Variables.

202. THEORY OF FUNCTIONS OF A COMPLEX VARIABLE II (2)
Continuation of above. Prerequisite: AM 201.

205. ADVANCED NUMERICAL ANALYSIS I (2)
Numerical Solution of partial differential equations, finite dif-

ference methods, Monte Carlo techniques, relaxation methods, programming of representative problems for the IBM 1130. Prerequisites: AM 120, AM 121 and ability to program in Fortran.

206. ADVANCED NUMERICAL ANALYSIS II (2)
Matrix computations, eigen values of finite matrices, application of matrix methods to the solution of systems of linear equations, programming of representative problems for the IBM 1130. Prerequisite: AM 120, 121 or equivalent.

207. ADVANCED PROGRAMMING TECHNIQUES (2)
Fortran subprograms and functions. Treatment of common storage. Disk input/output. Machine organization and machine language programming. Monitor and supervise programs. Compilers. Mathematical programming techniques. Prerequisite: AM 121 and ability to program in Fortran.

208. SIMULATION AND MODEL THEORY
Simulation and emulation of systems. Networks, facilities through use of logical, statistical and numerical models. Programming or problems involving flow patterns, queues lengths, delays, transit lines, utilizations. Prerequisite: AM 121 and AM 207.

211. CALCULUS OF VARIATION I (2)
Euler-LaGrange Equation. Du Bois-Reymond Lemma Weierstras-Erdmann Conner condition. Legendre conditions. Noether's Theorem. Isoperimetric inequalities. Applications.

212. CALCULUS OF VARIATION II (2)
Continuation of AM 211.

215. MATRIX THEORY I (2)
Properties and operations, vector spaces and linear transforms, characteristic roots and vectors, inversion of matrices, applications. Prerequisite: AM 145.

216. MATRIX THEORY II (2)
Continuation of AM 215.

230. ADVANCED APPLIED MATHEMATICS I (2)
Functional spaces, vector and matrices, systems of orthogonal functions, linear spaces, manifolds, linear operators, spectral theory, functions of operators and matrices, Green's functions, delta functions, differential operators, eigen function representation of operators, perturbation methods, operators for partial differential equations.

231. ADVANCED APPLIED MATHEMATICS II (2)
Continuation of AM 230.

232. ADVANCED APPLIED MATHEMATICS III (2)
Continuation of AM 231.

233. NON-LINEAR DIFFERENTIAL EQUATIONS I (2)
Theory of non-linear equations, existence of solutions, uniqueness of solutions, first order equations, second order equations, special methods, non-linear integral equations, Periodic solutions and asymptotic methods. Prerequisites: AM 137 and AM 145.

234. NON-LINEAR DIFFERENTIAL EQUATIONS II (2)
Continuation of AM 233.

235. VECTOR AND TENSOR ANALYSIS I (2)
Vector algebra and calculus, advanced vector calculus, cartesian tensors and applications in mechanics and field theory. This course provides the basic vector and cartesian-tensor background neded in fluid mechanics, elasticity and electromagnetics.

236. VECTOR AND TENSOR ANALYSIS II
Continuation of AM 235.

237. VECTOR AND TENSOR ANALYSIS III
Continuation of AM 236.

240. OPERATIONS RESEARCH I (2)
Deterministic models: formulation and solution of linear programming problems, including transportation and assignment problem; simplex method, duality; theory of games; PERT. Prerequisite: AM 111.

241. OPERATIONS RESEARCH II (2)
Discrete stochastic models: Markov chain models, flow graph techniques. Continuous stochastic models: asymtotic behavior of discrete models. Digital computer simulation: Monte Carlo methods and design of simulation experiments. Applications to systems problems involving queing, reliability storage, search and surveillance. Prerequisite: AM 111. (AM 240 is not a prerequisite.)

242. OPERATIONS RESEARCH III (2)
Continuation of AM 241.

260. DYNAMIC PROGRAMMING I (2)
Review of elementary set, probability and function theory. Invariant embedding and dynamic programming. Stochastic decision processes. Dynamic programming processes. Existence and uniqueness theorems. Prerequisites: Advanced calculus, matrix theory and probability theory.

261. DYNAMIC PROGRAMMING II (2)
Continuation of AM 260.

262. STOCHASTIC PROCESSES I (2)
Types of stochastic processes, stationarity, ergodicity, differentiation and integration of stochastic processes, correlation and power spectral density functions, linear systems, band limit pro-

cesses, estimation, nonstationary processes, normal processes, Markov processes. Prerequisite: AM 111.

263. STOCHASTIC PROCESSES II (2)
Continuation of AM 262.

270. TOPOLOGY I (2)
Sets and functions. Metric spaces. Topological spaces. Compactness. Separation. Connectedness. Approximation. Fixed point theorems and applications to analysis. Concepts of algebraic topology.

271. TOPOLOGY II (2)
Continuation of AM 270.

274. PARTIAL DIFFERENTIAL EQUATIONS I (2)
Relation between particular solutions, general solutions and boundary values. Existence and uniqueness theorems. Wave equation and Gauchy's problem. Potential theory and Dirichelet's problem. Heat equation. Prerequisite: AM 132.

275. PARTIAL DIFFERENTIAL EQUATIONS II (2)
Continuation of AM 274.

298. SPECIAL PROBLEMS (1 to 2 units)
By special arrangement.

299. M.S. THESIS

CIVIL ENGINEERING (CE) AND ENGINEERING MECHANICS (EM)

HENRY V. HAHNE, PH.D., *Chairman*

Professor: HENRY V. HAHNE
Associate Professor: A. MORGAN JOHNSON, HAROLD M. TAPAY
Assistant Professor: FRANCIS YAO, S.J.
Lecturer: SATHYANARAYANA HANAGUD,
WILMOT J. NICHOLSON, ROBERT E. SMITH

Civil Engineering relates to works in connection with transportation, such as highways and traffic, railways and canals; to structural works, such as bridges, buildings, dams, piers, and many other structures constructed of wood, steel, or reinforced concrete; to sanitary works and works which have to do with water, such as the collection, purification, and distribution of water for a municipal supply; the collection, treatment and disposal of sewage; the drainage of some lands and the irrigation of others.

Engineering, or applied mechanics, is a field of graduate study which encompasses subject matter fundamental to the analysis and design of engineering systems, including such subjects as dynamics, stress analysis, and mechanical behavior of materials. While the products of these

analyses – structures, machines, systems – are more widely known than the methods of analysis, this area continues to serve well the needs of those students who are interested in the more analytical aspects of engineering and are aiming toward a career in teaching, research or specialized work in industry such as many phases of aerospace studies.

Undergraduate Courses

10. SURVEYING
Survey instruments – their use, adjustment, and care. Principles of topographic mapping, linear measurements, leveling, traverses, curves, earthwork, boundary and public surveys. Field practice.

15. STATICS
Concept of force and equilibrium. Force systems in plane and in space. Trusses. Friction. Principle of virtual work and its application.

20. GEOLOGY AND HYDROLOGY
Physical and chemical properties of rock-forming minerals, and rock materials. Ground-water hydrology, stream and shoreline processes. Laboratory.

110. DYNAMICS
Dynamics of a particle and dynamics of rigid bodies. Introduction to theory of vibrations, balancing of machinery, and theory of the gyroscope. Prerequisites: PH 4 and CE 15.

111. STATICS AND DYNAMICS
Fundamental principles of statics. Dynamics of a particle and dynamics of rigid bodies. Application to problems in engineering. Prerequisite: PH 4.

115. MATERIALS ENGINEERING
Origin, manufacture, and processing of materials used in civil engineering. Significant properties of metals, wood, cement, and other engineering materials. Corrosion and its prevention. Fire resistance.

116. STRENGTH OF MATERIALS
Analysis of stresses and strains in bodies under the action of loads. Mohr's circle. The concept of strain energy and its applications. Laboratory. Prerequisite: CE 15.

118. CONSTRUCTION ENGINEERING I
Licensing. Drawings and specifications. Cost Analysis, estimating and bidding. Contracts. Bonds. Financing. Insurance. Labor Legislation. Planning and scheduling.

121. SOIL MECHANICS AND FOUNDATION DESIGN
Theoretical and experimental methods of analysis of the physical

properties of soils. Design of earth structures. Introduction to the design and analysis of various types of foundations. Laboratory. Prerequisites: CE 116 and CE 20.

123. ADVANCED SOILS ENGINEERING (2)
Theory of clay mineralogy. Soil compaction characteristics and equipment. Consolidation of soils, time-settlement relationship. Slope and foundation stability. Design, and remedial treatments of soft foundations.

130. STRUCTURAL ANALYSIS I
Analysis of stresses in statically determinate structures under stationary loads. Roof and bridge trusses. Straight and curved beams. Frames. Three-hinged arches. Influence lines for beams. Prerequisite: CE 116.

131. STRUCTURAL ANALYSIS II
Influence lines for bridge trusses and simple arches. Analysis of deformations of structures. Introduction to statically indeterminate structures and the analysis of building frames using moment-distribution method. Introduction to plastic analysis. Prerequisite: CE 130.

133. STRUCTURAL STEEL DESIGN
Riveted and welded connections. Tension and compression members. Floor systems and roof trusses. Detailing and shop practice. Industrial buildings. Bridges. Prerequisite: CE 130.

135. REINFORCED CONCRETE DESIGN
Analysis and design of reinforced concrete structures. Introduction to elementary concepts of plastic theory and the theory of prestressed concrete. Concrete mixes and construction methods. Prerequisite: CE 130.

140. HYDRAULIC AND SANITARY ENGINEERING
Descriptive and quantitative hydrology. Collection, storage and distribution systems. Dams, reservoirs, and canals. Sewage treatment plants. Introduction to the chemical and biological processes in water purification and sewage treatment. Prerequisite: Fluid Mechanics.

142. ADVANCED SANITARY ENGINEERING (2)
Advanced aspects of the physical, chemical, and biological processes involved in water purification and in sewage and waste treatment. Principles of the design and operation of treatment plants. Special aspects of industrial waste treatment.

145. HIGHWAY DESIGN
Highway planning, economy, and finance. Highway design, construction, and maintenance. Pavements and bases. Prerequisite: CE 121.

146. URBAN AND REGIONAL PLANNING
Principles of city and regional planning. Land use and zoning. Population estimation. Subdivisions. Transportation, traffic and sanitary engineering problems associated with city planning.

148. CONSTRUCTION ENGINEERING II
Construction methods and equipment. Legal aspects of construction. Construction site organization. Prerequisite: CE 133 and CE 135.

All candidates for the B.S. degree in Civil Engineering are required to carry out a thesis project during their senior year, to participate in the engineering seminar, and to submit an acceptable thesis to the Department prior to graduation.

Graduate Courses in Engineering Mechanics

150. ADVANCED STRENGTH OF MATERIALS I (2)
Beams on elastic foundation. Curved beams. Thin rings. Bending of beams with nonsymmetrical cross section, principal axes of inertia and principal moments of inertia. Mohr's circle in three dimensions.

154. STATICALLY INDETERMINATE STRUCTURES I (2)
Thermal stresses. Stresses due to foundation settlements. Stresses due to shrinkage and creep of structural materials. Application to trusses, beams, frames, and arches.

155. STATICALLY INDETERMINATE STRUCTURES II (2)
Deformations of statically indeterminate structures. Iterative methods of analysis. Space frames. Application of digital computers. Influence lines. Prerequisite: CE 154.

157. THEORY OF PLATES (2)
Methods of analysis of rectangular plates under various loading and support conditions. Fourier series, energy methods and numerical finite difference methods. Analysis of circular plates.

158. THEORY OF SHELLS I (2)
Membrane theory of shells of revolution. Cylindrical shells, shell roofs, tanks. Bending theory of cylindrical shells.

160. THEORY OF PLASTICITY I (2)
Analysis of stresses and strains in materials loaded beyond the elastic limit. Perfectly plastic materials. Bending of beams and torsion of shafts. Yield hinges, limit analysis. Application to trusses and frames.

161. EXPERIMENTAL STRESS ANALYSIS (2)
Theory and practice of the photoelastic method for measuring stresses under static and dynamic loads. Moire screen method in photoelasticity. Electrical strain gages and rosettes, and their use in static and dynamic testing. Mechanical and optical strain gages.

163. TENSOR METHODS IN CONTINUUM MECHANICS (2)
Introduction to tensor calculus and its application to problems of engineering mechanics. Analysis of stresses and strains in solid bodies for various loading conditions.

165. DYNAMICS OF STRUCTURES I (2)
Introduction to the analysis of behavior of structures under time-dependent loads. Natural frequencies of structures. Response of structures to various types of dynamic loading. Exact and approximate methods.

168. THEORY OF STABILITY OF STRUCTURES I (2)
Stability analysis of elastic bars under axial and combined axial load and bending. Columns with elastic restraints. Analysis of frames. Energy methods.

170. ADVANCED MECHANICAL PROPERTIES OF MATERIALS (2)
Theory of flow and fracture of engineering materials. Mechanical properties of engineering materials at low and elevated temperatures. Effect of radiation on mechanical properties. Laboratory investigations in creep, fatigue, and impact. Nondestructive testing.

190. INDEPENDENT RESEARCH
Open to Departmental Scholars only.

199. INDEPENDENT STUDY
Open to Departmental Scholars only.

210. ADVANCED STRENGTH OF MATERIALS II (2)
Thick-walled rings. Shrink-fit stresses. Beam analysis, using Fourier series. Torsion of thin-walled sections. Shear center. Theories of failure. Nonlinear problems in beam bending. Strain energy.

212. THEORY OF ELASTICITY I (2)
Fundamentals of the classic theory of elasticity. Stress and strain in three dimensions. Plane stress and plane strain. Stress function. Problems in rectangular and polar coordinates. Analysis of

stresses around holes and in the vicinity of localized loads. Prerequisite: CE 150.

213. THEORY OF ELASTICITY II (2)

Torsion of noncircular shafts. Contact stresses. Numerical methods and application of the digital computer. Application of conformal mapping and use of complex variables in solving plane stresses around holes and in the vicinity of localized loads.

215. THEORY OF PLASTICITY II (2)

Introduction to mathematical theory of plasticity. Plastic analysis of plates and rings. Shake-down phenomena. Visco-elastic behavior of materials. Creep phenomena. Prerequisite: CE 160.

217. THEORY OF SHELLS II (2)

Bending theory of shells. Stress function and numerical methods in shell analysis. Shells of negative curvature and shallow shells. Shells of variable thickness. Prerequisite: CE 158.

219. DYNAMICS OF STRUCTURES II (2)

Analysis of the dynamic behavior of multistory frames. Matrix methods. Application of digital computers. Theoretical foundations of earthquake analysis. Dynamic response of elastic bodies, beams, plates. Prerequisite: CE 165.

220. THEORY OF STABILITY OF STRUCTURES II (2)

Refined methods of stability analysis of frames. Stability of rings and arches. Lateral stability of beams. Stability of plates. Introduction to stability of shells. Stability of structures in the inelastic range. Prerequisite: CE 168.

225. AIRCRAFT AND MISSILE STRUCTURES I (2)

Applications of principles of engineering mechanics. Strain energy methods. Castigliano's theorems. Space frameworks. Thin-walled structures. Stability. Matrix methods. Use of electronics computers. Prerequisite: CE 150.

226. AIRCRAFT AND MISSILE STRUCTURES II (2)

Shear lag problems. Application of methods of limit analysis. Stability of thin-walled sections in torsion and in bending. Thermoelasticity and application of matrix methods. Honeycomb structures. Properties and applications of nonmetallic materials. Prerequisite: CE 225.

227. AIRCRAFT AND MISSILE STRUCTURES III (2)

Large deflection theory of plate structures. Stress analysis, sta-

bility analysis and dynamic response characteristics of sandwich structures. Prerequisite: CE 226.

230. THERMAL STRESSES (2)

Formulation and solution of thermoelastic problems. Analysis of beams, rings, frames, trusses, and plates. Thermoelastic stability and thermal stress analysis for inelastic systems. Prerequisite: CE 150.

231. THERMAL STRESSES II (2)

Deflections of structures subjected to thermal loading. Thermoelasticity and plasticity. Creep of structures due to thermal loading. Stability. Prerequisite: CE 230.

232. THEORY OF VISCOELASTICITY (2)

Characteristics of various viscoelastic materials, stress-strain relationships, stress problems, vibrations. Problems in two and three dimensions.

233. THEORY OF ANISOTROPIC ELASTICITY (2)

Stress-strain relationships for various anisotropic models. Stress analysis problems including beams and plates. Concepts of the theory of vibration and wave propagation.

235. IMPACT, SHOCK, AND WAVE PROPAGATION (2)

Elementary concepts of longitudinal wave propagation in bars, spalling, transform techniques of analysis; plastic waves and shocks in bars. Introduction to elastic waves in three dimensions and impact buckling.

236. THEORY OF WAVE PROPAGATION (2)

Introduction to three-dimensional wave propagation. Surface waves, plane waves. Wave propagation in inelastic bodies. Lamb's problem.

237. SHOCK WAVES IN SOLIDS II (2)

Thermodynamic constitutive relations for solids, thermodynamic effects in shock propagation, strain rate effects, the concepts of wave propagation in three dimensions. Discussion of current research.

299. M.S. THESIS (1 to 6)

By arrangement with the Department.

ELECTRICAL ENGINEERING (EE)

SHU-PARK CHAN, PH.D., *Chairman*

Professor: SHU-PARK CHAN
Associate Professor: HENRY P. NETTESHEIM, JACK A. PETERSON, DRAGOSLAV D. SILJAK, RAYMOND B. YARBROUGH
Assistant Professor: TIMOTHY J. HEALY, JOSEPH D. MANDELL
Lecturers: JOHN D. BRUCE, HAUS R. CAMENZIND, CHARLES H. DAWSON, EDWARD A. HUBER, NEIL INGLES, HARMON W. JOHNSON, TUCK HOP LEE, ROBERT N. LINEBARGER, RALPH LOVE, RICHARD D. SMALLWOOD, IRVING STEIN, GABOR C. TEMES, GEORGE J. TAHLER, KEITH I. THOMASSEN, NOEL PAGE THOMPSON, THOMAS WHITNEY

Electrical Engineering includes the design, construction, and operation of equipment for generation, transmission, and utilization of electrical energy. Electrical engineers are concerned with all phases of the electrical transmission of information such as radio, television, and telephone. Data processing equipment and computers used by business, industry, and government are included in their major area of interest. Much of the equipment used in maintaining our national security is powered and controlled by electric and electronic mechanisms.

3. INTRODUCTION TO COMPUTING
Basic computer functions, Fortran programming. Information processing, number systems and computer logic functions. Simulation and games. Algonthms. Programming for statistics. History of computers and computation. Libraries, medical diagnosis and the humanities and the computer. Artificial intelligence. For non-engineering students. Prerequisite: High school algebra or MA 1.

101. PRINCIPLES OF ELECTRICAL ENGINEERING I
Parameters of electrical components, introduction to circuit theory, principles of electromechanical energy conversion, transient and steady-state behavior of electrical systems. Laboratory. Prerequisites: PH 4B, MA 21.

102. PRINCIPLES OF ELECTRICAL ENGINEERING II
A continuation of EE 101 to include the basic principles of energy conversion. Introduction of the basic principles of electronics. Elementary theory of vacuum, gas, and solid state electronic devices. Applications to basic electronic circuits as used in communications and industrial electronic systems. Laboratory. Prerequisite: EE 101.

103. ELECTRICAL INSTRUMENTATION AND CONTROL
Introduction to system theory analysis, determination of models for electromechanical and electronic equipment. Analytical tech-

niques for both open- and closed-loop control systems. For non-Electrical Engineering majors. Laboratory. Prerequisite: EE 101.

104. FUNDAMENTALS OF ELECTROMAGNETIC FIELDS
Static electric and magnetic fields, dielectric and magnetic materials. Time-varying fields. Transmission line theory. Introduction to antennas and propagation. Prerequisite: EE 101.

105. ELECTROMAGNETIC FIELDS (2)
An accelerated review course. Not for graduate credit.

106. ENGINEERING AND THE TECHNOLOGICAL SOCIETY
Engineering as a discipline. The foundation concepts of engineering. The history and development of western technology. The impact on society and the social consequences of engineering and technology. Automation and the computer revolution.

108. MICROWAVE THEORY AND TECHNIQUES
A combined lecture and laboratory course covering generation, propagation, and detection of microwave energy. Experiments on klystrons, impedance measurements, antenna radiation patterns, and the characteristics of passive microwave devices. Laboratory. Prerequisite: EE 104.

111. NETWORK ANALYSIS
Loop-basis and node-basis network analysis, elementary network topology, Laplace transforms, network functions, poles and zeros. Prerequisite: EE 101.

112. INTRODUCTION TO NETWORK SYNTHESIS
An introduction to modern synthesis methods, properties of driving-point and transfer functions. Methods of synthesis of LC, RC, and RLC one-port networks. Approximations. Linear filter theory. Prerequisite: EE 111.

113. ANALYSIS OF LINEAR SYSTEMS (2) Not for Graduate Credit
Formulation of loop and node equations, network theorems, transfer functions, operational methods, including Laplace and Fourier integrals, s-plane analysis. Prerequisite: EE 101.

131. CONTROL SYSTEMS
Detailed consideration of the mathematical theory of linear feedback control systems. Topics include: transfer functions, relation between time and frequency domain characteristics; analysis and design, using root locus concepts and frequency response plots; performance criteria and sensitivity; stability. Laboratory. Prerequisite: AM 118.

132. AUTOMATIC FEEDBACK CONTROL SYSTEMS (2) Not for Graduate Credit
Introduction to analysis of feedback systems. Stability frequency

and time response. Nyquist, Bode, and Nichols plots. Root locus, steady-state error. Prerequisite: EE 113.

151. ELECTRONICS I
Electron ballistics, emission theory, semiconductor theory. Extension of the study of electronic amplifiers to include wideband and radio frequency amplifiers, and the principles and applications of feedback. Laboratory. Prerequisites: EE 102, EE 111.

152. ELECTRONICS II
Continuation of EE 151, to develop features of high-frequency power amplifiers, oscillators, modulation systems. Communications systems. Introduction to nonlinear electronic circuits. Laboratory. Prerequisite: EE 151.

161. ELECTROMECHANICAL ENERGY CONVERSION
Introduction to energy conversion equations and applications to transducers, rotating amplifiers. Machine dynamics, transfer function realization, and modeling of physical electromechanical systems. Laboratory. Prerequisites: EE 102

162. INTRODUCTION TO POWER SYSTEM ANALYSIS (2)
Introduction to matrices, topology, and one line diagrams. Fundamentals of load-flow analysis, three-phase symmetrical faults and unbalanced faults. Concepts of symmetrical components and Clark's components are analyzed.

171. BIOLOGY FOR ENGINEERS
Selected topics in biology of pertinent interest to engineers. Introduction to cell structure and function, bioenergetics, control of cellular processes, genetics, structure and function of the human body. Laboratory.

190. UNDERGRADUATE RESEARCH
Open to Departmental Scholars only.

198. SENIOR THESIS AND SEMINAR
Investigation of an approved electrical engineering problem and preparation of suitable thesis covering the investigation. Conferences as required. The seminar will be presented by the student during the term, covering suitable topics.

199. INDEPENDENT STUDY
Open to Departmental Scholars only.

201. ELECTROMAGNETIC FIELD THEORY I (2)
Time-varying electromagnetic field concepts starting with Maxwell's equations. Use of electric and magnetic vector potentials. Field theorems. Reflection and refraction of plane waves at interfaces. Rectangular wave guides and resonators. Boundary value problems in cartesian coordinates. Prerequisite: EE 104.

202. ELECTROMAGNETIC FIELD THEORY II (2)
Cylindrical and spherical wave functions. Circular wave guides and resonators. Spherical cavities. Boundary value problems in cylindrical and spherical coordinates. Prerequisite: EE 201.

203. MICROWAVE NETWORKS I (2)
Elements of microwave networks. Wave guide and coaxial line components. Wave-guide impedance-matching elements, phase shifters, attenuators. Magic tee, wave meters, directional couplers. Prerequisite: EE 201.

204. MICROWAVE NETWORKS II (2)
General microwave transmission theory. Methods of analysis including the use of matrix algebra to microwave networks. Waveguide junctions and other microwave networks. Prerequisite: EE 203.

205. ACTIVE MICROWAVE DEVICES (2)
Microwave detectors, amplifiers, and oscillators. Klystrons, magnetrons, traveling wave tubes, masers, and ferrites. Prerequisite: EE 201.

206. ANTENNAS I (2)
An introductory course in antennas. Generalized antenna problem from assumed currents. Analysis of basic antennas; elementary dipole, thin linear antennas, loops, helical antennas, reflectors, horn antennas, and arrays. Prerequisite: EE 201.

207. ANTENNAS II (2)
A continuation of EE 206. Frequency independent antennas, biconical antennas, log-periodic antennas, conical spirals, signal processing antennas. Prerequisite: EE 206.

209. TOPICS IN ELECTROMAGNETIC FIELD THEORY (2)

211. MODERN NETWORK ANALYSIS I (2)
A study of network theory from modern points of view: Fundamental concepts, loop and node systems of equations, matrix methods, elementary topology, and network theorems. Prerequisites: EE 111; credit or registration in Complex Variables, AM 135.

212. MODERN NETWORK ANALYSIS II (2)
Continuation of EE 211. Frequency analysis of excitation and response, study of network responses, using Laplace transformation methods and superposition integral, network functions and their properties. Prerequisite: EE 211.

213. LINEAR SYSTEM ANALYSIS (2)
Mathematical methods in the design and analysis of linear systems: complex variables, Fourier and Laplace transforms,

signal-flow diagram, stability problems, and selected topics. Prerequisite: EE 211.

214. NETWORK GRAPH THEORY (2)
Introduction to the theory of graphs: formulation of topological basis of mesh and node methods by means of matrix transformations, proofs of network theorems, and topological analysis and synthesis of electrical networks. Prerequisite: EE 211.

215. NETWORK SYNTHESIS I (2)
A study of various methods for the synthesis of passive networks for prescribed driving-point and transfer characteristics. Prerequisite: EE 211.

216. NETWORK SYNTHESIS II (2)
A continuation of EE 215. Synthesis of passive two-ports: ladder development, resistively terminated networks, double-terminated networks, image parameter method, approximations. Prerequisite: EE 215.

217. NETWORK SYNTHESIS III (2)
A continuation of EE 216. Introduction to n-port synthesis, topological synthesis, selected topics. Prerequisite: EE 216.

219. TOPICS IN NETWORK THEORY

221. DIGITAL SYSTEMS I (2)
Digital systems organization.
Number systems and digital information codes. Introduction to Boolean algebra and switching circuits. Analysis and synthesis of combinational switching circuits.

222. DIGITAL SYSTEMS II (2)
Introduction to sequential circuits.
Synchronous and asynchronous circuit design. Logical design of arithmetic and control units. Derivation of application equations.

223. DIGITAL SYSTEMS III (2)
Memory sections, input-output equipment, graphic systems, hybrid operations. Introduction to programming and software systems. Hardware-software tradeoffs. Real time systems analysis and design.

224. ANALOG COMPUTER SIMULATION (2)
Simulation of linear and nonlinear equations, representations of transfer functions. Nonlinear function generation, diode networks, relay systems. Magnitude and time scaling. Laboratory. Prerequisite: Differential equations.

225. ANALOG/HYBRID COMPUTER SIMULATION (2)
Introduction to simulation by hybrid methods. Includes systems

using analog logic and storage, systems using digital logic and control. Parameter optimization, iteration. Prerequisite: EE 222.

226. DIGITAL SYSTEMS LABORATORY (2)
Study and implementation of principal digital systems features and operating units. Laboratory experiments with combinational circuits, synchronous and asynchronous circuits, counters, control units, serial-parallel arithmetic, input-output, graphics, A/D and D/A conversion, hybrid circuits.

229. TOPICS IN DIGITAL SYSTEMS (2)

231. DESIGN OF FEEDBACK CONTROL SYSTEMS (2)
Design of linear, continuous control systems utilizing techniques for the frequency response method and the root-locus method. Time and frequency response correlation and steady-state analysis is discussed. Prerequisite: EE 131.

232. ANALYSIS AND DESIGN OF NONLINEAR FEEDBACK CONTROL SYSTEMS (2)
Graphical and analytical techniques for analyzing nonlinear systems. Phase plane and describing function techniques applied to relay servos, dual mode servos, and servomechanisms with discontinuous damping. Prerequisite: EE 131.

233. INTRODUCTION TO SAMPLED-DATA SYSTEMS (2)
Introduction to the analysis of systems operating on discrete signals, by means of transformation calculus and state space techniques. Prerequisite: EE 131 or equivalent.

234. SYNTHESIS OF SAMPLED-DATA SYSTEMS (2)
Continuation of EE 233. Design of control systems by pulsed networks and digital controllers. Multivariate sampling. Optimum system design. Statistical design of sampled systems. Nonlinear systems. The Z transform and the state variable methods will be used. Prerequisite: EE 233.

235. NONLINEAR CONTROL SYSTEM THEORY (2)
Introduction to dominant mode analysis. Design and compensation with nonlinear elements and time-varying parameters. Adaptive control systems. Prerequisite: EE 131.

236. INTRODUCTION TO STATE SPACE TECHNIQUES (2)
Concepts of state and state equations. State vector and state equations of differential equations. Determination of stability by Liapunov's method. Prerequisite: EE 131.

237. GUIDANCE AND CONTROL LAWS FOR AEROSPACE VEHICLES (2)
Linearization of nonlinear trajectories. Introduction to optimiza-

tion of control systems. Kalman's prediction method. Prerequisite: EE 236.

238. STATISTICAL CONTROL THEORY (2)
Analysis and design of control systems responding to stochastic input signals. Kalman's prediction methods. Analysis of noise in systems. Design of optimum response for continuous control and guidance systems. Prerequisite: EE 236.

239. TOPICS IN CONTROL THEORY (2)

241. THEORY OF COMMUNICATION
A general introduction to problems of communication. Probability. Fourier series representation. Channel limitations. Modulation. Noise. Propagation. Prerequisite: EE 113.

242. INFORMATION THEORY I (2)
An introduction to the fundamental concepts of information theory, including the quantitative measure of information, entropy, and channel capacity for both discrete and continuous systems. Prerequisite: AM 110.

243. INFORMATION THEORY II (2)
A continuation of EE 242. Network analysis with random signals and noise. Statistical decision theory applications. Prerequisite: EE 242.

244. ERROR DETECTION AND CORRECTION CODING (2)
Treatment of block codes; their structure and their capabilities, including cyclic codes for burst error detection and correction. The implementation of encoding and decoding algorithms for cyclic codes is discussed. Prerequisite: AM 140.

245. SIGNAL DETECTION THEORY
(Offered in Spring of odd-numbered years)
The Digital Communication System. Signal detection in a noisy environment. Decision criteria. Hypothesis testing. Parameter Estimation. Adaptive Systems. Prerequisite: EE 241, AM 110, AM 111.

246. COHERENT COMMUNICATION THEORY
(Offered in Spring of even-numbered years)
Phase Control. Phase-locked-loops. Noise effects. Coherent communication. Modulation schemes. Uncoded and coded systems. Prerequisite: EE 241, AM 110, AM 111.

249. TOPICS IN COMMUNICATION THEORY (2)

251. FUNDAMENTALS OF TRANSISTORS AND CIRCUITS (2)
Physics of transistors, equivalent circuits, simple amplifiers. Prerequisite: EE 152.

252. TRANSISTOR CIRCUIT DESIGN (2)
Stability, low-frequency response, feedback, D.C. amplifiers, power amplifiers, power supplies. Prerequisite: EE 251.

253. HIGH-FREQUENCY TRANSISTOR CIRCUITS (2)
High-frequency equivalent circuits, neutralization, tuned amplifiers (signal), tuned amplifiers (power), switching characteristics, noise problems. Prerequisite: EE 252.

254. WIDE-BAND AMPLIFIERS I—LOW PASS (2)
Special equivalent circuits, complex frequency approach, steady state and time response. Prerequisite: EE 252.

255. WIDE-BAND AMPLIFIERS II—LOW PASS (2)
Continuation of time response analysis. Complex plant representation. Gain Functions. Additive Amplifiers. Prerequisite: EE 254.

256. WIDE-BAND AMPLIFIERS III—BAND PASS (2)
Low-pass to band-pass transformations, design data, impedance transforms, double tuned and triple tuned interstages. Prerequisite: EE 255.

257. TIMING AND PULSE GENERATION (2)
Regenerative switching and wave-form generation, effects of inductance in switching and pulse circuits, pulse-forming circuits and high-power pulse amplifiers. Prerequisite: EE 263.

259. TOPICS IN ELECTRONIC CIRCUITS (2)

260. INTRODUCTION TO NONLINEAR MAGNETICS (2)
The physical properties of ferromagnetic materials: magnetic domain structure, domain walls, reversible and irreversible magnetization, hysteresis, and the dynamics of magnetization. Magnetic measurements. Charasteristics of various magnetic materials.

261. ANALOG AND DIGITAL APPLICATIONS OF MAGNETIC DEVICES (2)
(Offered odd-numbered years)
Circuit models of magnetic cores developed from material and geometrical properties. Analysis and design of: magnetic amplifiers, static inverters and converters, and pulse logic circuits.

262. MAGNETIC DIGITAL COMPUTER MEMORIES (2)
(Offered even-numbered years)
Organization and selection circuits for coincident and linear selection memory schemes. Device and array characteristics for ferrite core, planar film and coated wire memories.

263. SWITCHING DEVICES (2)
Suitable equivalent circuits. Semiconductor switching characteristics: delay, storage time, recovery time, charge control parameters. Circuit techniques: circuit theorems, solution of differential equations with boundary values by inspection. Elementary switching applications. Prerequisite: EE 251.

264. SEMICONDUCTOR DEVICE THEORY I (2)
The physics of semiconductor junctions and materials presented as a basis for the development of physical models of junction transistors. Various models compared and their merits in various applications discussed. Prerequisite: A senior-level course in transistor electronics and a course in modern physics.

265. SEMICONDUCTOR DEVICE THEORY II (2)
A continuation of EE 264, including other semiconductor devices, with emphasis on surface phenomenon and field effect transistors. Prerequisite: EE 264.

266. INTEGRATED CIRCUIT DESIGN (2)
Survey of integrated circuit processes. Comparison of discrete and integrated components. Component selection, tolerances, yield, heat dissipation and interconnection. Design approaches for digital and linear integrated circuits. Prerequisite: EE 264.

269. TOPICS IN MAGNETICS AND MAGNETIC TECHNOLOGY (2)

271. BIOLOGICAL SYSTEMS I (2)
Introduction to the functioning of living systems at the cellular level. Cell structure and composition, generation and flow of energy through living systems. The control of metabolic processes. Introduction to genetics, biological information storage and retrieval. Not recommended for students who have taken a recent college level course in biology or biochemistry.

272. BIOLOGICAL SYSTEMS II (2)
Introduction to the functioning of the human body. Nervous system and nerve function, circulatory, respiratory, endocrine, excretory systems and reproduction. EE 271 recommended, but not required to be taken first. Not recommended for students who have taken a recent college level course in biology or physiology.

273. BIOLOGICAL CONTROL SYSTEMS (2)
Cybernetics, biosystems, modeling, and evaluation of linear and nonlinear systems theory applied to biosystems. Examples of bioengineering approaches to the pupillary control system, the development of muscular contractile force and the nature of cardiac dynamics.

274. BIOENGINEERING MEASUREMENTS (2)
Problems involved in measurements, data presentation and reduction. Selected examples of electric and mechanical measurements in animal systems. Prerequisite: EE 271.

276. BIOLOGY LABORATORY FOR ENGINEERS (1)
Introduction to quantitative laboratory techniques and procecedures in biology. Designed to accompany EE 271 and EE 272 which must be taken concurrently. Experimental topics each term are correlated with the lecture topics.

279. TOPICS IN BIOENGINEERING (2)

280. POWER TRANSMISSION SYSTEMS (2)
Calculation of transmission line parameters. Sequence impedances, bundled conductors, multiplex calculations. Introduction to EHV systems, AC and DC operation. Switching transients and voltage recovery.

281. COMPUTER ANALYSIS OF POWER NETWORKS I (2)
Introduction to network topology, Matrix algebra, incidence matrices. Development of Z-BUS, Y-BUS, Z-LOOP, etc., by singular and nonsingular transformation. Three phase analysis including symmetrical and Clark's components. Short circuit studies and relaying.

282. COMPUTER ANALYSIS OF POWER NETWORKS II (2)
Numerical analysis, load flow studies, load representation, transformer modeling. Development of reduction techniques including triangularization and diakoptics. Network equivalents.

283. POWER SYSTEM CONTROL (2)
Load frequency control, real and reactive power dispatching, loss formula formulation and solution. Application of computer control, analog and digital. Introduction to optimal economic control of power systems. Prerequisite: EE 282 and EE 236.

284. POWER SYSTEM ECONOMIC THEORY (2)
Introduction to economic system design, application of dynamic programming techniques in economic optimal design. Study of economic wire size programs, station size and voltage levels.

285. ELECTROMECHANICAL ROTATING DEVICE THEORY (2)
Development of system models for control-type rotating devices including D.C. motors, pointed circuit motors, torque motors. Analysis of double reaction methods for analysis of two-phase induction machines. Modeling of stepper motors.

286. POWER SYSTEM STABILITY (2)
Introduction to machine dynamics and electrical transients of synchronous machines. Modeling of fossil-fuel, nuclear and water wheel power plants. Excitation systems and controls. Two ma-

chine stability, equal area criterion and swing equations. Large system dynamics, mechanical and electrical transients.

287. DISTRIBUTION SYSTEM PLANNING (2)
Planning techniques as applied to electrical utility distribution planning. Analytical techniques and computer applications. Load forecasting, economic sizing of substations, economics conductor sizing. Voltage control by reactor and capacitor methods. Optimum placement of capacitor on radial feeders. Power factor correction. Transformer management.

288. POWER SYSTEM SEMINAR (2)

289. SPECIAL STUDIES IN POWER SYSTEMS (1-4 units)

290. MAGNETIC RECORDING I (2)
Anhysteretic magnetization process, particle interactions, unbiased and unidirectional biased recording.

291. MAGNETIC RECORDING II (2)
The magnetic reproducing process. Properties of magnetic media. Prerequisite: EE 290.

292. MAGNETIC RECORDING III (2)
Recording techniques and systems. Prerequisite: EE 291.

299. ELECTRICAL ENGINEERING PROBLEMS (2-4 units)
Special Electrical Engineering problems. By arrangement.

300. THESIS RESEARCH (3-9 units)
Electrical Engineering research conducted under the supervision of a faculty advisor. Preparation of a suitable written thesis covering the investigation.

MECHANICAL ENGINEERING (ME)

Richard K. Pefley, M.E., *Chairman*

Professor: Richard K. Pefley, Michel A. Saad
Visiting Professor: Stuart W. Bowen
Associate Professors: Eugene J. Fisher, Robert Ian Murray, Stein Weissenberger
Assistant Professor: David A. Oliver
Lecturers: Peter J. Aline, Robert F. Burt, George G. Herzl, Mamoru Inouye, Roy A. Jensen, Norman G. Kulgein, Saul Levy, Harris B. McKee, John R. Viegas, Marcel Vinokur, Robert K. Wedell

Mechanical Engineering attracts those engineers who are interested in propulsion, ranging from hydraulic jets and propellers to rockets; in power generation, ranging from solar heat engines to nuclear power

plants; in explosions of all types, extending from the housed explosion in the internal combustion engine to free bomb-type explosion; in heating, refrigeration, and air conditioning, ranging in application from human comfort to the cooling of vacuum tubes; in structures subjected to motion, extending from printing presses and calculators to guided missiles.

Mechanical engineers are concerned not only with the design of this variety of machines, products, and equipment, but also with the design and operation of the factories, mills, and plants in which manufacturing and processing take place.

Undergraduate Courses

10. DESIGN I
Fortran programming; principles of orthographic projection and descriptive geometry. Graphic analysis of lines, surface areas and volumes. Methods and solutions for simple design problems are presented.

11. DESIGN II
Influence of material selection and manufacturing processes on engineering design.

15. MATERIAL SCIENCE
Physical basis of the electrical, mechanical, and thermal behavior of solids. Relations between structural and physical properties. Theory of dislocations, vacancies, and other defects and their effect on physical properties. Prerequisites: Physics, Chemistry.

110. MACHINE DESIGN I
Analytical and graphical analysis of linkages, utilizing statics, dynamics, and strength of materials. Machine elements studied will include electromechanical and pneumatic-hydraulic components. Prerequisites: CE 116, ME 11.

111. MACHINE DESIGN II
Continuation of Machine Design I. System analysis and synthesis will be studied, including control systems. Solutions to design problems will be critically evaluated by employing case studies. Prerequisite: ME 110.

113. ANALYSIS OF LINEAR SYSTEMS (2)
Formulation of loop and node equations, network theorems, transfer functions, operational methods, including Laplace and Fourier integrals, s-plane analysis. Prerequisite: EE 101.

118. THERMOFLUID MECHANICS I-C
Similar to ME 120, but with applications and laboratory work slanted toward Civil Engineering. Prerequisite: CE 110.

119. THERMOFLUID MECHANICS II-C
Similar to ME 121, but with applications and laboratory work slanted toward Civil Engineering. Prerequisite: ME 118.

120. THERMOFLUID MECHANICS I
Consideration of thermofluid properties of matter, Newton's laws of motion, and the laws of thermodynamics. Emphasis is placed on the application of these principles to the analysis of fluid systems. Laboratory work emphasizes dimensional analysis as a guide to experimental studies of fluid flow. Prerequisite: CE 111.

121. THERMOFLUID MECHANICS II
Continuation of ME 120. Emphasis is placed on control volume analyses of thermofluid systems and on the implications of the second law of thermodynamics for such systems. Laboratory work stresses evaluation of system performance. Prerequisite: ME 120.

122. THERMOFLUID MECHANICS III
Continuation of ME 121 with emphasis on 2nd law concepts, nonreactive and reactive mixtures of substances. Laboratory work includes analysis of modern energy conversion systems. Prerequisite: ME 121.

123. GAS DYNAMICS
Introduction to one-dimensional compressible flow of gases, isentropic flow, normal shock waves, frictional flow and adiabatic flow. Prerequisite: ME 121.

125. THERMODYNAMICS
Thermodynamic potentials and availability concepts. Reactive mixtures with emphasis on the thermodynamics of combustion and chemical equilibrium. Prerequisite: ME 122.

131. CONTROL SYSTEMS
Detailed consideration of the mathematical theory of linear feedback systems. Topics include: transfer functions, relation between time and frequency domain characteristics; analysis and design, using root locus concepts and frequency response plots; performance criteria and sensitivity; stability. Laboratory. Prerequisite: AM 118.

132. AUTOMATIC FEEDBACK CONTROL SYSTEMS (2)
Introduction to analysis of feedback systems. Stability. Frequency and time response. Nyquist, Bode, and Nichols plots. Root locus, steady-state error. Prerequisite: ME 113.

135. HEAT TRANSFER
Introduction to the concepts of conduction, convection, and radiation heat transfer, and application of these concepts to engineering problems. Prerequisite: ME 121.

136. PROPULSION SYSTEMS
Common parameters for evaluation of marine, terrestrial, and space propulsion systems. Description and analysis of various types of propulsion systems. Prerequisite: ME 123.

138. NUCLEAR REACTIONS
Introduction to principles underlying nuclear power reactor design. Senior standing required.

140. ADVANCED DYNAMICS
Derivation and solution of equations of motion of dynamic systems. Lagrange's equations, with applications to vibration problems. Introduction to nonlinear systems and the phase plane. Introduction to feedback control systems. Prerequisite: CE 111.

142. ADVANCED FLUID MECHANICS I
Mechanics of laminar and turbulent flow. Introduction to potential flow and boundary-layer theory. Application to selected topics in lubrication theory, aerodynamics, and turbomachinery. Prerequisite: ME 121.

143. ADVANCED FLUID MECHANICS II
Application of fluid mechanics principles to flow in piping networks and manifolds. Transient phenomena, including water hammer. Analysis of systems containing turbomachinery. Prerequisite: ME 121.

198. THESIS AND SEMINAR
Investigation of an engineering problem and writing of an acceptable thesis. Conferences as required. Prerequisite: Senior standing in Mechanical Engineering.

199. INDIVIDUAL STUDY
By special arrangement with the Chairman of the Department. Credit by arrangement.

Courses Primarily For Graduates

210. NONLINEAR OSCILLATIONS I (2)
Phase plane and phase trajectories. Singular points. Topology of phase trajectories in the neighborhood of singular points. Methods of isoclines and Lienard construction. Conservative systems. Discontinuous systems. State space. Stability. Prerequisite: ME 140.

211. NONLINEAR OSCILLATIONS II (2)
Lyapunov's direct method. Stability of the first approximation. Applications, including rigid body motion. Computation of stability domains. Time-varying systems. Absolute stability. Limit cycles and topological methods. Poincare'-Bendixson theorem. Perturbation techniques. Methods of Koryloff and Bogoliuboff. Describing function. Prerequisite: ME 210.

215. ADVANCED DYNAMICS I (2)
Dynamics of a particle, solution of rectilinear and oscillatory motion for linear and quadratic damping, large-angle oscilla-

tions, self-excited oscillations, Duhamel integral. Two-hour lecture. Prerequisite: Differential Equations.

216. ADVANCED DYNAMICS II (2)
Momentum and energy theorems, motion of systems with variable mass, relative motion, generalized coordinates and forces, Lagrangian equations, time-dependent constraints, applications to physical problems. Two-hour lecture. Prerequisite: ME 215.

217. ADVANCED DYNAMICS III (2)
Free and forced motion of gyroscopes, gyroscopic moments, stability of gyroscopic motion, theory of small vibrations, free and forced oscillations of systems with several degrees of freedom. Two-hour lecture. Prerequisite: ME 216.

218. CLASSICAL MECHANICS I (2)
Vectorial mechanics of a system of particles. Variational principles. Lagrange's equations. Conservation laws. Hamilton's principle. Kinematics of rigid body motion. Inertia tensor. Prerequisite: ME 217.

219. CLASSICAL MECHANICS II (2)
Hamilton's equations. Rigid body dynamics. Stability of motion. Applications to satellite attitude control.

220. CELESTIAL MECHANICS I (2)
Review and extension of conic geometry and spherical trigonometry, the Kepler orbit, problems in ideal orbits, orbit determination, Newtonian modifications to the Kepler planetary system, alternative formulations of, and approaches to, orbital mechanics, error analysis, applications of orbit mechanics to atomic physics. Two-hour lecture. Prerequisites: Differential Equations and Dynamics.

221. CELESTIAL MECHANICS II (2)
Potential theory, perturbation theory, satellite motion about oblate earth, effects of atmosphere on satellite orbits, physics of the solar system. Two-hour lecture. Prerequisite: ME 220.

222. CELESTIAL MECHANICS III (2)
Powered trajectories, ascent and re-entry, orbital maneuvers, attitude control, mission analysis, lunar and interplanetary flight. Two-hour lecture. Prerequisite: ME 221.

225. GAS DYNAMICS I (2)
Flow of compressible fluids including one-dimensional isentropic flow, normal shock waves, frictional flow. Two-hour lecture. Prerequisite: ME 121.

226. GAS DYNAMICS II (2)
Continuation of ME 225, including effects of heat transfer and generalized one-dimensional flow. Oblique shocks and two-di-

mensional potential flow. Two-hour lecture. Prerequisite: ME 225.

227. GAS DYNAMICS III (2)
Continuation of ME 226, with emphasis on the method of characteristics for supersonic flow. Two-hour lecture. Prerequisite: ME 226.

228. GAS DYNAMICS IV (2)
Flow of gases analyzed from a microscopic viewpoint. Two-hour lecture. Prerequisites: ME 225 and ME 230.

229. EQUILIBRIUM THERMODYNAMICS (2)
Extremum principles of thermodynamic equilibrium. Equations of state, thermodynamic potentials, phase transitions and thermodynamic stability. Theory of chemical equilibrium. Extensions and application to elastic systems and systems in the presence of fields. Prerequisite: ME 125 or equivalent.

230. STATISTICAL THERMODYNAMICS (2)
Kinetic theory of gases, Maxwell-Boltzmann distributions, thermodynamic properties in terms of partition functions, quantum statistics and applications. Two-hour lecture. Prerequisites: Differential Equations and ME 121.

231. NONEQUILIBRIUM THERMODYNAMICS (2)
Macroscopic dynamic and thermodynamic conservation principles for continuum systems. Entropy production, entropy balance, and the nonequilibrium state principal. Linear theory of nonequilibrium processes such as viscous flow, heat conduction, diffusion, chemical reactions and electrical conduction. Onsager-Casimir reciprocity and the principle of minimum entropy production. Applications to systems of engineering interest. Prerequisites: ME 229 and ME 266.

234. COMBUSTION (2)
Theory of combustion processes. Reaction kinetics, flame propagation theories. Two-hour lecture. Prerequisites: Differential Equations and ME 121.

236. CONDUCTIVE HEAT TRANSFER I (2)
Flow of heat through solid and porous media for steady and transient conditions. Consideration of stationary and moving heat sources. Two-hour lecture. Prerequisites: Differential Equations and ME 135.

237. CONDUCTIVE HEAT TRANSFER II (2)
Continuation of ME 236.

238. CONVECTIVE HEAT AND MASS TRANSFER (2)
Advanced problems in heat and mass transfer, with emphasis on convective heat and mass transport. Two-hour lecture. Prerequisite: ME 135.

239. TWO PHASE FLOW–HEAT AND MOMENTUM ANALYSIS (2)
Considerations of possible flow regimes for closed conduits in terms of pressure drop, void fraction, and heat flux. Prerequisites: ME 271, ME 135 or equivalents.

240. RADIATION HEAT TRANSFER (2)
Introduction to concepts of quantum mechanics, black body behavior and radiant heat exchange between real bodies. Two-hour lecture. Prerequisite: ME 135.

241. SPACECRAFT TEMPERATURE CONTROL (2)
Heat transfer aspects of spacecraft design. Environment and onboard considerations. Prerequsite: ME 135 or equivalent.

243. CRYOGENICS (2)
Thermodynamics, heat transfer and fluid mechanics aspects of cryogenic systems.

250. NUCLEAR REACTOR I (2)
Diffusion, slowing down and reaction of neutrons in nuclear reactors which determine fuel loading and reactivity conditions with fission product poisoning and burnup for reactor design; operation and control in homogeneous or heterogeneous fast intermediate or thermal neutron systems.

251. NUCLEAR REACTOR ENGINEERING II (2)
Special problems occurring in the energy removal and structural design of reactors and radiation protection, safeguards and reactor shielding problems occurring in nuclear system design. Fuel cycles, reprocessing and nuclear reactor economic evaluations. Prerequisite: ME 250.

252. REACTOR THEORY I (2)
Group formulation in diffusion approximations for neutron reactions occurring in fissile and fertile isotopes with resonance escape probabilities leading to the neutron slowing down formulation with the Fermi Age treatment and thermalization of neutrons. Prerequisite: ME 251 or Physics 125.

253. REACTOR THEORY II (2)
Treatment of bare and reflected homogeneous and heterogeneous reactors including time varying neutron density, Xenon transients and control with applications of perturbation theory to solution of reactor problems and the treatment of the Boltzmann transport of neutrons. Prerequisite: ME 252.

255. ADVANCED PROPULSION SYSTEMS (2)
Advanced topics in the analysis of propulsion systems, with emphasis on recently conceived systems. Two-hour lecture. Prerequisite: ME 136, ME 123.

257. ROCKET PROPELLANTS I (2)
Major characteristics of propellants and their relation to rocket design.

266. INTRODUCTION TO ADVANCED FLUID MECHANICS CONCEPTS I (2)
Basic principles and mathematical techniques of incompressible, inviscid flows. Properties of equations, flows about simple bodies. Prerequisite: ME 121.

267. INTRODUCTION TO ADVANCED FLUID MECHANICS CONCEPTS II (2)
Continuation of ME 266.

268. INTRODUCTION TO ADVANCED FLUID MECHANICS CONCEPTS III (2)
Continuation of ME 267.

270. PHYSICAL PROPERTIES FROM THE MOLECULAR VIEWPOINT (2)
Microscopic theories of deformation and fracture. Electrical, thermal, and magnetic properties of materials. Two-hour lecture. Prerequisite: ME 15 or equivalent.

272. VISCOUS FLOW THEORY I (2)
Navier-Stokes equations with Prandtl boundary-layer simplifications. Solutions for incompressible laminar and turbulent flow. Prerequisites: ME 121 and AM 130 or equivalent.

273. VISCOUS FLOW THEORY II (2)
Energy equation including heat conduction. Solutions for incompressible thermal boundary layers. Compressibility effects. Turbulent flow. Prerequisite: ME 272.

274. VISCOUS FLOW THEORY III (2)
Boundary layers in hypersonic flow, including effects of mass addition, dissociation, and chemical reactions. Prerequisite: ME 273.

275. TRANSIENT HYDRAULIC ANALYSIS (2)
Applications of fluid mechanics principles to flow in piping networks and manifolds. Analysis of systems containing turbo machinery. Prerequisite: ME 121.

276. THE NATURE OF TURBULENCE (2)
An introduction to turbulence phenomena, parameters, idealizations, and approximate methods of analysis. Prerequisite: ME 142 or equivalent.

277. DIMENSIONAL ANALYSIS AND APPROXIMATION THEORY (2)
Determination of governing parameters for experimental studies and model tests: Buckingham's Pi Theorem, normalization of governing equations and boundary conditions. Order of magni-

tude estimates and justification for simplified differential equations.

278. INTRODUCTION TO HYPERSONIC FLOW
Approximate and exact solutions for inviscid flow of a perfect gas or real gas in equilibrium around two dimensional and axisymmetric bodies. Prerequisite: ME 266 series.

280. MAGNETOHYDRODYNAMICS AND PLASMA PHYSICS I (2)
Introduction to the physical principles and underlying properties of electrically conducting media. Elements of electromagnetic theory and the dynamics of charged particles. Thermodynamics and kinetic theory of ionized gases. Debye shielding, plasma oscillations, ionization and atomic processes, collisions, and relaxation times. Prerequisite: familiarity with electricity and magnetism.

281. MAGNETOHYDRODYNAMICS AND PLASMA PHYSICS II (2)
Fluid conservation equations for conducting media. Transport properties and electrical conduction in ionized gases. Simple magnetohydrodynamic flows, and magnetohydrodynamic waves. Elements of magnetohydrodynamic stability. Applications in power generation, energy conversion, and propulsion. Prerequisite: ME 280.

290. ACCOUSTICS AND NOISE CONTROL (2)
Methods of analysis and control of accoustical vibrations.

297. SEMINAR (1 or 2)
A series of discrete lectures on current problems and progress in fields related to mechanical engineering.

298. SPECIAL PROBLEMS (3 to 9 units)
By arrangement.

299. RESEARCH M.S. THESIS (3 to 9 units)
By arrangement with the Department.

PHYSICS (PH)

The following courses will be scheduled in conjunction with the early-morning engineering graduate program.

125. ELEMENTARY MODERN PHYSICS (2)
Special relativity. Quantum effects. The hydrogen atom. Many-electron atoms. X-rays. Nuclear structure and nuclear reactions.

135. PHYSICS OF SOLIDS (2)
The crystalline state. Theories of specific heat. Metallic lattices. Dielectric properties of insulators. Free-electron theory of metals: Prerequisite: PH 115 or equivalent.

136. PHYSICS OF SOLIDS (2)
Continuation of 116A. Band theory of solids. Electron distribution in insulators. Nonpolar semiconductors. Rectifiers and transistors. Diamagnetism and paramagnetism. Prerequisite: PH 116A.

145. ATOMIC PHYSICS (2)
Magnetic, electrical, and optical properties of atoms. X-rays and X-ray spectra. Optical spectra. Electron spin and multiplet spectra. Prerequisites: PH 115 and PH 180A.

146. NUCLEAR PHYSICS (2)
Review of natural and artificial radioactivity. Detailed study of alpha, beta, and gamma decay. Nuclear forces and nuclear structure. Prerequisite: PH 125.

155. QUANTUM MECHANICS I (2)
The Schrodinger Equation. Free particle. Linear harmonic oscillator. Barrier problems. General methods for one-dimensional problems. Three-dimensional problems. Prerequisite: PH 125.

156. QUANTUM MECHANICS II (2)
Time-independent perturbation theory. Time-dependent perturbation theory. General formulation of quantum mechanics and applications. Prerequisite: PH 180A.

COURSES IN OTHER DEPARTMENTS OF THE UNIVERSITY OF INTEREST TO ENGINEERS

Chemistry 5	Chemistry for Physicists and Engineers I
Chemistry 6	Chemistry for Physicists and Engineers II
Mathematics 1	Algebra and Trigonometry
Mathematics 11	Analytical Geometry and Calculus I
Mathematics 12	Analytical Geometry and Calculus II
Mathematics 13	Analytical Geometry and Calculus III
Mathematics 21	Calculus and Differential Equations
Physics 4	Physics for Scientists and Engineers I
Physics 5	Physics for Scientists and Engineers II
Physics 6	Physics for Scientists and Engineers III
Physics 7	Physics for Scientists and Engineers — Modern Physics
Physics 131	Methods of Mathematical Physics I
Physics 132	Methods of Mathematical Physics II
Business 1, 2	Fundamentals of Accounting
Business 133	Cost Accounting
Business 157	The Elements of Management Science
Business 160	Organization and Management
Business 162	Business Policies and Management

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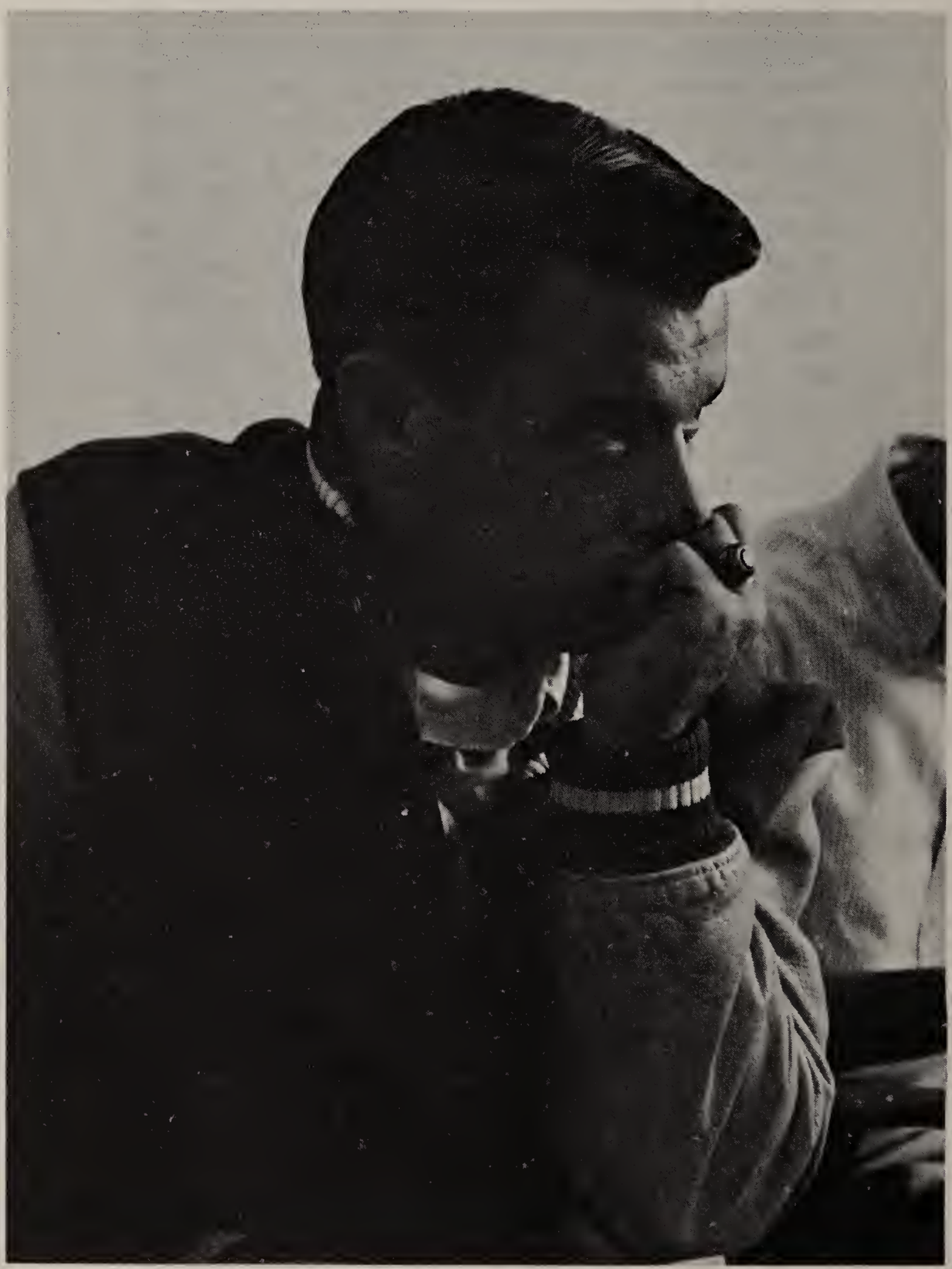
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